THE

POPULAR SCIENCE MONTHLY.

APRIL, 1885.

THE CHARACTER AND DISCIPLINE OF POLITICAL ECONOMY.

By J. LAURENCE LAUGHLIN, Ph. D.,

ASSISTANT PROFESSOR OF POLITICAL ECONOMY IN HARVARD UNIVERSITY.

WALTER BAGEHOT once said of certain literary economists, who had no bent for practical affairs, that they were "like astronomers who had never seen the stars." In fact, no small number of people believe that this applies to all political economists; that they do very well as students of books, but are unable to keep their heads in the midst of facts and actual business; and that only the "hard-headed" merchant is competent to explain the causes of what he sees to the uninitiated. As in many general beliefs, there is something just and right in this; and yet there is something too which is not included in it, which leads the holder of the belief to narrow and illiberal conclusions in regard to a very important study. A fair and candid consideration should be given to the qualities of mind called into play by the study of political economy, and then we may more easily judge of the character of the work demanded of an economist, and of the way in which these demands have been met.

It is axiomatic that not every person can succeed in political economy any more than in art or music. Some people, although admirably equipped in other directions, have attacked political economy with great zeal, only to realize finally that anything beyond a certain general knowledge and use of its principles is denied to them. Any hint, therefore, although imperfect as mine may be, of a knowledge of the mental qualities requisite for success in such a study, will at least set to thinking those who propose to begin it, and possibly lead those

who do not intend to study it to consider whether they have formed a right judgment upon the work already accomplished by economists.

The mental qualities brought into use by political economy are of two seemingly opposite kinds; and, simply because of this distinct opposition between them, few persons combine them both, and consequently few persons have achieved great success in the study. To illustrate best the mental operations required, let me first recount briefly the process followed in an economic investigation. Certain phenomena are observed, and their accuracy ascertained; an hypothetical explanation, or a statement of the cause operating to produce the observed phenomena, is made on the best possible ground known to the investigator; a process of verification then follows, wherein the hypothetical principle is applied to other observed economic facts; and, if it explains the given conditions in all known cases, the law is considered established—just as we proceed to discover a law in physics (although the economic law is not capable of quantitative accuracy in statement like the physical law). First, there is observation, then deduction, and lastly inductive verification, with a severe and exacting standard. Or, to again use the words of Bagehot, we act as if a man were arrested under suspicion of murder: a murder was known to have been committed, and the doer of the crime has been suspected; and then, if, on resort to legal and just proof, the suspicion is found correct, he is declared guilty. Likewise, when economic phenomena are observed, the law expressing the relation between cause and effect is suspected; and if, on comparison with the facts, this law is wholly substantiated—as it were, "found guilty"—it is considered established.

By the deductive part of the process, the *logical* and reasoning powers are called forth in a marked degree. Hence economic study needs, and in its processes gives, the discipline of the severer logical and mathematical subjects. And many years of observation in the classroom warrants the statement that, as a rule, he who enjoys and masters mathematical and logical work will succeed with political economy, provided he has to some extent also the other necessary mental qualities. What these other qualities are may be seen by considering that, in the inductive part of the process above described, an imperative need exists for an honest, practical *appreciation of facts*, such as is possessed by merchants and men of affairs, coupled with an *economic intuition*, a faculty which is more or less innate, and not very much, in my opinion, a matter of cultivation. The capacity to collect and arrange facts is a book-keeper's function; but the ability to see through the confusing mass of details and trace the operation of a governing principle, requires an intuitive regard for facts and their causes possessed in a large measure hitherto by only a few men. If this analysis be a true one, it will appear distinctly how it is that qualities almost diametrically opposed to each other are necessary for

the equipment of an economist of the first rank. On the one hand, he must have the power of close, sustained, and logical reasoning; on the other, he must have a most thoroughly practical spirit, without vagaries and nonsense. The former he gains chiefly by his academic training; the latter, by general maturity and an intuitive or practical knowledge of the world of business. In short, he must be at once a (so-called) "doctrinaire" and a "practical man." To be without one set of these faculties is to seriously and fatally prevent any great usefulness. A purely "practical man," without the logical training, can no more achieve economic success than a railway-locomotive, no matter how great its steam-power, can continue to run and reach its destination without rails. And yet, a bookish and literary economist, without the practical intuitions, can accomplish nothing more than a finely finished and most perfect engine in the hands of an ignoramus who does not know how to get up steam. We here find the explanation of a very common belief among the wide ranks of the busy and successful men of affairs in the United States—a class who have generally had little academic training—that economists are mere "doctrinaires," whose assumptions are all *a priori*, all in the air, and above the level of every-day work; who had better make a fortune in pig-iron, or fancy dress-goods, before they set up to instruct the community. Merely making money, however, does not at the same time make one logical. It is as if we should demand that every scientific physicist or chemist should have first put his knowledge into practice by inventing some application of electricity, or a patent-medicine, before he is competent to impart the principles of his science to others. The contempt of the practical world for (so-called) "doctrinaires" is as great a mistake as for the speculative writers to set themselves above the men of affairs. As in most things, the correct position lies somewhere between. If an economist is an abstract thinker, and nothing else—unable to verify his deductions—then he justly merits contempt; but in that case he is not a properly equipped man, as we have described him above. On the other hand, it is common to see merchants or manufacturers showing great energy in studying and writing upon economic subjects, who, so long as they confine themselves to the range of facts within the limits of their own horizon, make most valuable and effective contributions to the verification of principles; but, when, without accuracy, logical power, or a grasp upon governing principles, they begin to generalize upon their limited data, they are very apt to be less effective and useful than they are dogmatic. He only is truly an economist who, eagerly studious of facts, not in one occupation or place only, but in as many as possible, applies scientific processes to his investigation, and produces that which becomes the world's truth, the property of men of all times—not the petty sum of thought which has grasped only a small fraction of the facts. In other words, when a wide-awake man goes to books, he

really goes to get the experience of the best observers of all countries with which to correct himself against false and narrow inferences drawn from his own limited experience.

In order to show how far this analysis is based on experience, some appeal to the history of the work of the most successful economists will give results of an interesting and instructive kind. Adam Smith, Ricardo, Mill, and Cairnes combined in a high degree the two almost opposite kinds of powers needed for their success; and these men have contributed the most to the progress of our knowledge of economic principles. It would be hard to name an author who has wielded a greater influence by his writings than Adam Smith by his "Wealth of Nations" (1776). His work was a great and admitted success, as tried by any tests, whether of popularity or permanent influence on men's minds. But on his tombstone will be found inscribed the name of an extensive ethical work ("The Theory of Moral Sentiments") as an equal claim to distinction with the "Wealth of Nations." What is worth noting is that the great writer was a Professor of Moral Philosophy in Glasgow, and had planned an extensive course of lectures in which political economy formed but one part; and we find that by training, by aptitude, by study, he was a skillful master of logic; he had the power to separate the temporary and unimportant from facts, and educe an abstraction of the truth unweighted by the accidents of the form in which he found it; and knew how to secure a firm grasp upon principles apart from their illustrations, which gave him later a scientific and systematic control over his subject, and enabled him to weld it into a compact and cohering whole. It was this power which made it possible for him to lay the foundations of a science of political economy. It widened his views, and made it easy for him to see the essentials of any concrete phenomena. In short, he possessed in a remarkable degree the first of the two requisites for successful economic work. But, then, to an almost equal extent, he honestly reverenced industrial and commercial facts; he studied them eagerly, and made his book an extensive collection of data on many special subjects. Everywhere one meets with the analysis and study of particular industrial phenomena; and in them the keen, observing Scotchman, with a subtile, economic instinct, saw the operation of laws where the ordinary man of affairs saw only a crowd of familiar and monotonous details of business. The practical nature of his work is so well known that it seems unnecessary to call further attention to this side of his make-up. So well is this understood, that the late Cliffe-Leslie claimed for Adam Smith that his method of working was solely inductive, that is, starting from facts alone. It was, therefore, without question, his philosophic and logical faculty, united with a true and correct instinct for facts and the laws working in them, which lay at the bottom of Adam Smith's world-wide success in his "Wealth of Nations." He had the power to see the universal in the concrete; to

disclose the operating force; to shake off the incidental circumstances of its concrete envelope, take out the principle, and formulate it for use by others in subsequent explanations. The great Scotch "doctrinaire" was at once the most practical man of his time.

Curiously enough, while Adam Smith approached political economy from the side of abstract and metaphysical studies, his "homely sagacity" led him constantly to practical results; but, although Ricardo was a rich banker and a successful man of business, who had early retired with a competence, he it was who, above all others, went farthest in attempting to formulate the principles he had arrived at from facts in a form which should state abstractly the general truths independent of the changing conditions in which these principles worked. So that in Ricardo we have a man of business intuitions of the most practical kind, but one who early showed a fondness for mathematics and logical studies. Knowing only too well the myriad shapes in which facts arise before us, he was urged forward by a desire to express truth in a form as succinct and universal as possible. This tendency, taken in connection with unusual terseness and no great literary skill in exposition, has deceived people into thinking that his conclusions were all deduced by an *a priori* process (because of his dry and peculiar method of stating them); while, as a matter of fact, he was a hard-headed man of affairs, living at a time when the Bank of England restriction act and the duties on corn led him to try to find out the fundamental principles which were governing the value of money and the price of corn. The results of these practical investigations were seen in the doctrines of the "Bullion Report," and the economic doctrines of "Rent" and "International Trade." In this way, the work of the Scotch Professor of Logic, who had a great deal of practical insight, was supplemented by the study of a successful man of affairs who had a strong passion for concise and abstract statement of economic principles. We can not properly say of the man who was introduced to the details of the money market at fourteen, was in business on his own account at twenty-one, and was a wealthy man at twenty-five, that he was a doctrinaire wholly given over to abstract speculations.

John Stuart Mill illustrates what we have said in a different way. To him the fascination of abstract reasoning was so great, and the bent of his mind so strongly metaphysical, that this part of the economist's equipment preponderated in his make-up; his attention to the facts of practical life was not excessive. And this exposes the real weakness of his book. Perhaps no other systematic writer ever gained such a success by perspicuous treatment, and a certain geometrical symmetry in the connection of parts with a whole, as did Mr. Mill in his "Principles of Political Economy," and this quality has greatly added to the value of his work. But, while the abstract character of many of his chapters excites admiration for a power of sustained

reasoning which they showed, yet it must be confessed that they are too often ill-adapted to the common apprehension. Had he possessed more knowledge and acquaintance with practical business life, been nearer to the monotony of details, his work would have been imbued with a smack of practicality which would have redeemed its abstractness, and made it vastly more useful. Moreover, he would, as in the discussion of the wages question, have adapted his principles more correctly to the truth, and gained positions less likely to be assailed after others had noted their too great symmetry and too few limitations. His early training accounts for his book as it stands, and explains his faults. Account must, however, be taken of the life Mill led as a servant in the East India Company's office, which widened his horizon, gave his mind practical employment, and furnished him with a great field of experience in men and things. This, without doubt, exercised a strong and steadying influence on his thinking, which had some of the faults of English insularity, and, taken together with his robust philanthropy, gave that practical direction to his work which, while it was inadequate, yet redeemed him from the charge of being too entirely given to abstractions. Had he had an interest in work-a-day things which equaled his fondness for metaphysics and abstract thinking, he would have succeeded even more than he did, and he made a great success. His treatment of international values is a conspicuous example of his faculty for extended reasoning, but, had he put it more as a practical man of affairs, he could have made an exposition of the principles quite as well as he did, and gained vastly in his hold upon the reader. Does it not become evident, then, that mere philosophic acumen is not sufficient in the model economist? Nor, on the other hand, is the mere man of affairs able to grasp the workings of principles in the confusion of details. These two powers must be, and always are, combined in him who accomplishes the best economic work.

The personality of Mill's great successor, Mr. Cairnes, is a very interesting one. He both knew and thought much. Members of Parliament would come to sit by his invalid's chair, in which he was confined by a painful disorder, finally ending in an untimely death, and find him more learned than they in the details and facts of certain legislation; and yet with this accumulation of practical knowledge, for which he had a peculiar aptitude, no one since Ricardo has shown so vigorous a faculty for investigation, and the power of keeping his head while in the pursuit of principles. He was not befogged by metaphysical niceties, but followed his way through the multiplicity of actual business life with as sure and certain a grasp upon the actuating causes, and with as clear and definite a view of the principles in operation, as an expert accountant when adding a column of figures. His logical and philosophic side is most admirably seen in his little volume, "The Logical Method," in which he lays down his

ideas as to the processes to be followed in an economic investigation. Nowhere else does he seem more clearly to show how essentially he had the power to handle a purely abstract question, such as that of method. And yet, on the other hand, it is to be noticed in his "Leading Principles," that the whole criticism, by which he amends Mr. Mill's positions—his study of value, the wages question, and international trade—shows how much more appreciation he had of the real facts of trade than Mr. Mill. Under his economic penetration the cold columns of Australian statistics, and American exports and imports, glow with brilliant illustrations of general economic laws. Armed with this firm grasp upon principles, and the ability to see their operation in practical affairs, he examined the facts of our foreign trade before 1873, and came to the conclusion that we were rapidly accumulating the material for a great financial explosion, and actually prophesied the panic which came in that year. Scarcely anywhere is there a better illustration of the success arising from the possession of these two almost wholly unlike powers of mind which I have been trying to show are essential for the highest achievement in political economy. Mr. Cairnes was an economic tight-rope walker; he could go with a cool head through airy spaces where other men became dizzy or fell to the ground. And, at the same time, he had the Englishman's sturdy respect for facts, with more than the ordinary Englishman's willingness to acquaint himself with social systems different from his own.

These economists, whose powers I have attempted to analyze, have been the ones who have contributed most to our knowledge of the principles of political economy, as they are understood to-day. Above all other writers, these men have possessed a useful economic intuition, and a respect for facts, which have given peculiar strength to their clear, abstract generalization of results in the form of universal principles. Wherever other students and writers have accomplished less, it will appear that weakness arose from their entire or partial lack of one or both of these two sets of faculties. It explains some other things also. French writers are unexcelled in the power of lucid statement; but the generalizing and less practical French are not so likely to be good economists as the more common-sense English. Therefore, while the French have never much assisted the progress of political economy, they have stated results in the most admirable way. It is, then, reasonable also to expect that the practical Americans, with their keen insight and thoughtful disposition, may also furnish the material for excellent economists, whenever they set themselves seriously to get the proper training.

It may now be worth while to explain briefly some of the evident ways by which the study of political economy disciplines the mind. It may seem somewhat startling to say of so practical a sub-

ject that, in a pre-eminent degree, it calls for the exercise of imagination. "That is just what we have always said," the scoffers at political economy say at once; "so does novel-writing call for imagination, and a novelist is about as well fitted for the economist's position as the usual abstract thinker who masquerades as a teacher of political economy." To this it is to be replied that imagination is one of the chief requisites for mathematical study also; that a novelist is not necessarily a good mathematician, goes without saying. The simplest propositions of solid geometry require the exercise of imagination, as, for example, in the picturing of forms and solids with intersecting planes. The most logical student of the severest mathematical processes is called on for the exercise of this species of imagination. And so it is in political economy. In learning the subject, the perception of a simple general principle is often absurdly easy, but, for its assimilation into our own thinking, it is necessary that it should have become an interpreter of facts everywhere about us. To this end, it is essential for us to apply the abstraction, or general principle, in every possible case, to some concrete phenomenon. Very often, in order to show the action of this single principle operating by itself, we must separate all conflicting agencies from the situation—just as the physicist experiments in a vacuum exhausted of air, for the purpose of learning the full effect of a force, like gravity, when acting by itself. The economist, however, is not able to reproduce a given situation to the eye or ear, as is the physicist. He can not pile before him the exports of the United States or England, or summon before him the laboring-class or the capitalists of a country; he must, therefore, picture to himself the actual facts, just as the geometrician does the solid, and see how the operating principle works. This is very far from "theoretical dreaming." It is at once a most difficult process, and a most excellent discipline in learning how to think on such subjects. To illustrate my meaning in a simple way, it is one thing to say that in order to have value a commodity must satisfy some desire, and be hard to get; and quite another thing to be able to call up in the mind an image which will show the application of the principle. For example, to a shipwrecked sailor on a rocky island a bag of gold has no value, for it can not keep him alive. It is largely by such mental exercise as this that a student best succeeds in assimilating the body of principles which make up the science of political economy. It has been frequently said to me, "I can understand the statements of the writer easily, but I do not seem to be able to use the idea when called upon to explain things in a different connection." This is exactly the difficulty, as it is also, by struggling with the difficulty, the disciplinary gain of our study. To understand an abstract principle, without the ability to see it in the concrete form, and test its truth, is of little gain to any one. This would in truth make a "doctrinaire." The only "practical man," in any conceivable sense, is he who, while seeing

general principles, can best interpret the facts around him. To follow through a course of political economy without this attempt to think out the principles by use of the imagination, and by constant application to familiar facts, is like trying to climb a perpendicular slope of ice—the student will not catch hold.

In the next place, the disciplinary power of the study is very much that which is gained in the study and pursuit of the law. The beginner first gets an understanding of the principles, and he is then constantly engaged in turning with them to the economic phenomena around him as an exercise in their application. Or, struck by some new or interesting fact, he studies to find the law which explains the observed effects. In thus applying general principles to explain special facts, the economic student is doing almost exactly that which he does when, in the profession of the law, he applies legal principles to particular cases, or considers whether the interpretation of the law in one decision applies also to the special case he has in hand. The modern theory of legal teaching no longer recognizes the plan of simply filling the mind with statements of what the law now is, but aims to force the student, under oversight, constantly to apply principles to multitudes of cases, or to discover the principle running through the studied cases. It will, then, be seen that this process is much the same as in political economy. Consequently, quite apart from the "usefulness" of our study, its training is an excellent preparation for legal work, and strengthens the powers which are most called into play in that profession.

Moreover, this kind of mental exercise is continually calling upon one for the ability to see the pivotal part in any statement, whether of fact or principle. Not to see the essential bearing of an exposition is a species of mental blindness; but exercise will gradually give clearer vision. Nothing is more common in the replies of untrained students to questions than the happy-go-lucky kind of answers which bear upon the general subject, but are aside from the point. Persons may write or speak *about* the question, but do not answer it; what they may say may be quite true in itself, but it is irrelevant. The faculty of hitting a point is one, in my opinion, like concentration of mind (to which it is nearly allied), which is largely capable of cultivation and growth. And the discipline of rigorous study in political economy is one of the best means of acquiring it. In my experience, there have been some interesting illustrations of this analysis. Trained lawyers have, by heredity, transferred this faculty of directness of thought to their sons; and it has been possible, sometimes, without further data, to pick out the sons of lawyers from reading their examination-books in political economy. These sons "hit the nail on the head," and made clean work of their answers, without any mental shuffling, or avoidance of the essential point.

To make progress in such a study, the student must necessarily

gain exactitude and clearness, both in writing and speaking. Nothing is more striking to the instructor, as he faces a new class, than the limited powers of expression possessed by young men who have, in most cases, had a very extended course of classical training. It is largely due, of course, to vague and loose thinking. He who has clear ideas can generally manage to convey his meaning, in varying degrees of force, correctness, and elegance. The necessity, however, of making clear distinctions between things, which at first seem all alike, to see forces operating where none were seen before, stimulates unused faculties, and then progress becomes distinctly visible. Men who at the beginning expressed themselves in halting, inexact, and timid words, with a seeming passion for brevity, will, at the end of the course in which they have been constantly pushed to express themselves, talk easily and freely on subjects which would at first have frightened them by an appearance of abstractness. In this respect, the training must be much like that in the study of metaphysics. Under constant criticism looseness of words and definitions will disappear—as clearness of ideas comes in. In no other study is inexactitude and lack of precision in words or facts more likely to stir up criticism and ridicule than in political economy, because in no other study are persons more concerned with things which affect all the world in every day of its existence, and in which absurd results and stupid mistakes are more easily seen by everybody. The economist must be vigilant and correct; and the results of this requirement are such as tend to keep him as careful and exact as is possible. The effect of training under such conditions is admirable.

One other marked result of the study of political economy deserves at least passing mention. Persons who by nature are unfitted for other kinds of academic work, and yet by custom or authority have trodden the beaten educational paths with a dull sense of discouragement and incapacity, have, in many cases, been awakened to a hitherto unknown interest in study by the practical and interesting nature of the subject. Economic questions confront them everywhere, and they meet with the discussion of them over the table, on the walk, and in the newspapers. It, consequently, stimulates even a sluggish disposition to find that he can know something valuable about such practical matters of every-day importance. Livy or Thucydides may pall on his incapacity, but his curiosity may be piqued by having the functions of money explained to him. The purchasing power of his yearly allowance is something which comes home even to him. As enlarging the field for willing mental activity, and giving new and interesting objects for intellectual effort, political economy forms one of the most effective factors in the movement which in these latter days is liberalizing our courses of study, and is freeing us slowly from the cramped tyranny of a traditional training, still demanded, because, forsooth, it once seemed good to the school-men. Willing, enthusiastic study, because

it interests and fits the faculties, is a better thing for discipline than the serfdom of drudgery in a subject which excites no spontaneous response, and stirs an unwilling effort. And this is true, also, without any thought of undervaluing other branches of study. We must all admit that some minds are better fitted for one thing than for another, and that we can not do all things equally well. There is, therefore, a place for different studies so long as human abilities remain of a varied kind, and room should not be denied to any branch of learning which, apart from its "usefulness," is effective for mental discipline.

A warning, however, should be given at the outset which may save later disappointment in some cases. No one would think of becoming an accomplished chemist or geologist in one course pursued for one year; but many persons conceive that they can easily know all of political economy that is necessary for a sound judgment on passing questions in a less time than that. It is true that they can read over the statement of principles in a less time, but they can not become economists so easily. To have been trained until these principles become familiar as the alphabet requires time—time not merely for the intellectual efforts of applying the principles, but time for the mind to mature under the exertion and to digest its food slowly; since only by growth and experience does there come any development of the economic intuition, and a power to call readily upon any part of one's acquisitions for instant use at any moment. An elementary course will serve a distinct purpose as part of a liberal education for every citizen, but it will not make an economist "*teres atque rotundus*" at once; although honest work in a course for a year will give students no small advantage over those who have not had it. A brief course in chemistry may not enable the student to contribute at once to a new theory of heat, but it may give him a highly useful knowledge of the chemistry of every-day things. We must not, therefore, expect more from political economy than we do from other serious studies.

THE NERVOUS SYSTEM AND CONSCIOUSNESS.

By W. R. BENEDICT,

PROFESSOR OF PSYCHOLOGY AND LOGIC IN THE UNIVERSITY OF CINCINNATI.

I.

IT is the design of these papers to consider some of the more recent experiments and opinions as to the relations between nerve-matter and consciousness. The subject has been much be-written; the final word, however, is not in print, or likely to make its appearance there for some time to come. This is plain enough to anatomist and physiologist, and the general reader may assure himself to the same effect by reference to the proceedings of the Society for Psychical Research.

These proceedings offer a considerable number of facts not readily classifiable under any theory now at hand.

There is present and urgent need for a clear statement of the case respecting nerve-matter and consciousness. There is equally urgent need that this statement should be reasoned upon according to the fundamental working of reason—viz., the detection of difference and similarity. It is the proper reward of modern science to have taught that reasoning is the procedure from the known to the unknown by the pathway of resemblance. This resemblance must be experimentally determined and experimentally verified. Dr. Maudsley says, most truly, in his last edition of the "Physiology and Pathology of the Mind": "It will not advance knowledge to identify phenomena of a different kind by giving them the same name; on the contrary, the progress of knowledge lies in following the specializations of development, and in defining differences by a precise use of terms." The characteristic phenomena of nerve-matter and the characteristic phenomena of consciousness should be stated and compared: if these phenomena prove different, they should be described in the light of that difference, and all conclusion as to their origin should be drawn according to that difference. Our first inquiry, then, is concerning the nervous system, as to its parts and functions.

The histological elements of the nervous system are two, the fiber and the cell. The fiber appears under two forms, the medullated and non-medullated. The medullated fiber consists of a central thread or axial band, then a soft substance called the medulla, and, inclosing these, a tubular sheath. The axial band is the essential anatomical element of the fiber. It is an albuminoid substance—that is to say, it is highly unstable in character and complex in structure. The medullary substance is transparent, homogeneous, and strongly refracting, like oil; it consists chiefly of lecithin and cerebrin. The sheath is a lime-substance. The differences in chemical composition between this axial band and its marrow-like inclosure were shown by Lister and Turner in 1859. The band becomes red by a solution of carmine, while the marrow substance is unchanged, and in turn this substance becomes opaque and brown under chromic acid, while the band remains unaltered.

The second element of nerve-matter is the cell. This, in its fully developed condition, is of irregular shape, with strongly refracting granular contents and a distinct nucleus and nucleolus. Many of the cells have one or more prolongations, and are accordingly classed as unipolar, bipolar, or multipolar. One at least of the processes of a multipolar cell is continuous with a fiber and is called the axial-cylinder process. In the cells and in the intercellular substance of central nerve-organs, albuminoid stuff is closely mingled with the other component parts of nerve-matter.

The proportion of solids to water is but twelve per cent in the

cells, while it is twenty-five per cent in the fibers. This fact, taken in connection with the much greater provision for distribution of blood to the cell-mass, is strongly confirmatory of Mr. Spencer's opinion that the cells liberate motion by destruction of their substance, and the fibers by isomeric transformation.

The nerve-matter thus described is distributed over the body by two divisions—the great sympathetic and the cerebro-spinal systems. The latter alone concerns us in this paper. The nerve-matter of the cerebro-spinal system is found in the spinal cord and the encephalon. The spinal cord is a nearly cylindrical mass, from fifteen to eighteen inches long, and connected at its anterior extremity with the brain.

The cell-matter lies at the center and forms a continuous ganglionic band. The fibers are on the outside, and are divested of their tubular sheath. The central cell-matter of the cord is curiously shaped into two partial crescents, which are connected with one another by cell-substance called the gray commissure. Thirty-one pairs of nerves arise from the sides of the spinal cord and supply the entire body, except the head and other parts receiving branches from the cranial nerves. Each nerve leaving the cord contains, at its origin, all the filaments into which it may afterward be divided. Each filament or fiber remains anatomically distinct throughout its course. The fibers in the cord are connected by a commissure called the white commissure, and those on different sides of the cord extend longitudinally and are parallel to each other. Some of these longitudinal fibers, passing from below upward, convey impulses to the cord or brain; others, descending from the brain and higher parts of the cord, transfer motor impulses to muscles. Without presenting more anatomical detail, it is sufficient to say that the halves of the cord are unified by the fibers of the commissures, and that it works as one organ.

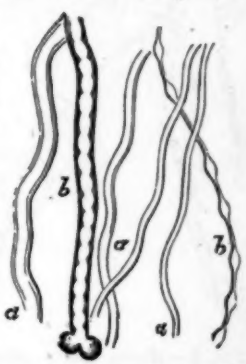

FIG. 1.—HUMAN NERVE-FIBERS OF DIFFERENT SIZES (Kölliker). *a*, *a*, *a*, healthy fibers, the largest of which is "dark-bordered"; *b*, *b*, fibers altered by exposure. Magnified 350 diameters.

The nerve-matter of the encephalon is divided into three principal parts, viz., the medulla oblongata, the cerebellum, and the cerebrum. The medulla is a continuation and enlargement of the spinal cord at its entrance into the cranial cavity. Here the anterior fibers of the cord become the anterior pyramids of the medulla, while the posterior fibers of the cord are called the restiform bodies. Immediately to the side of the pyramids are projections called the olivary bodies. The medulla is about one and one quarter of an inch long, and one inch broad at the widest part. There is cell-matter in the restiform and olivary bodies, a part of this matter being continuous with the cell-matter of the cord, and a part consisting of independent masses. Di-

rectly above the medulla is what is known as the pons Varolii. There are masses of cell-matter scattered at irregular intervals through the pons, but it is made up principally of longitudinal and transverse fibers.

The longitudinal fibers connect the medulla with the cerebrum, while the transverse fibers unite the halves of the cerebellum. This organ, the cerebellum, is made up of two hemispheres or lateral lobes and a median or central lobe. The cell-matter lies on the outside, the fibers are within. The external surface of the organ has a foliated appearance, caused by its subdivisions into multitudes of thin plates by numerous fissures. This subdivision allows great increase of cell-matter by numerous fine convolutions, and the matter is further augmented through penetration within of arborescent processes of cell-substance.

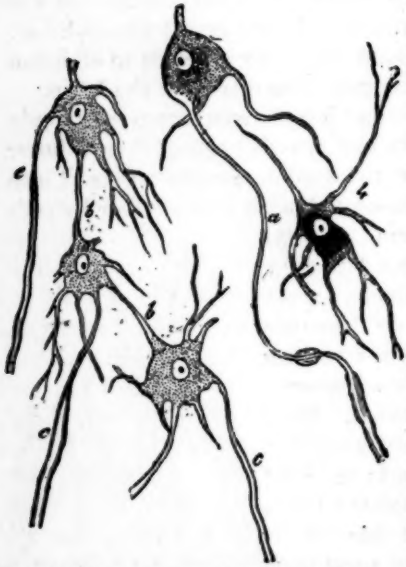

FIG. 2.—MOTOR NERVE-CELLS connected by intercellular processes (*b*, *b*), and giving origin to outgoing fibers (*c*, *c*, *c*, and *a*). 4. Multipolar cell containing much pigment around nucleus. Diagrammatic. (Vogt.)

The next portion of nerve-matter to be noticed is the cerebrum. This makes up more than four fifths of the contents of the encephalon. The cerebrum is egg-shaped, but flattened on its under side, and lies in the cranium with its small end forward. It is divided into halves or hemispheres by a great longitudinal fissure. These halves, however, are connected by a middle portion of nerve-substance called the corpus callosum. The surface of the cerebrum is molded into numerous convolutions marked off from one another by furrows. The cell-matter of the cerebrum is external, it follows the convolutions, and is from one twelfth to one eighth of an inch in thickness.

The hemispheres of the cerebrum have been divided into lobes called the frontal, parietal, occipital, and temporo-sphenoidal lobes. These divisions are in part arbitrary, while in part they rest upon certain primary fissures, such as the fissure of Sylvius and the fissure of Rolando. It should be borne in mind that these different regions of the cerebrum are not distinct departments physiologically independent. The convolutions are exteriorly connected among themselves and also with convolutions of neighboring lobes. They have, besides, interior connections through bundles of fibers which pass from one convolution to the base of an adjacent convolution. If we remove the encephalic mass and look at it from beneath, we see the medulla as a continua-

tion and enlargement of the spinal-cord; above this we see the pons Varolii, and to right and left the lobes of the cerebellum which lie under the posterior portions of the cerebrum. At the upper part of the pons we see two stems or crura passing to the cerebrum, and serving to join that larger organ with the nerve-matter below.

A little above the crura, and near the center of the mass, we see what is called the optic commissure. This is simply the crossing of the optic nerves on their way to the eyes. Directly below this commissure are two small rounded eminences called the corpora albicantia, while above, on a stem, is the pituitary body. Beyond the optic commissure lie the olfactory bulbs, one on each hemisphere, placed in a slight depression of the surface. If we turn the brain over, its numerous convolutions are seen extending from end to end, from side to side, and also following the lateral surfaces right and left of the great longitudinal fissure.

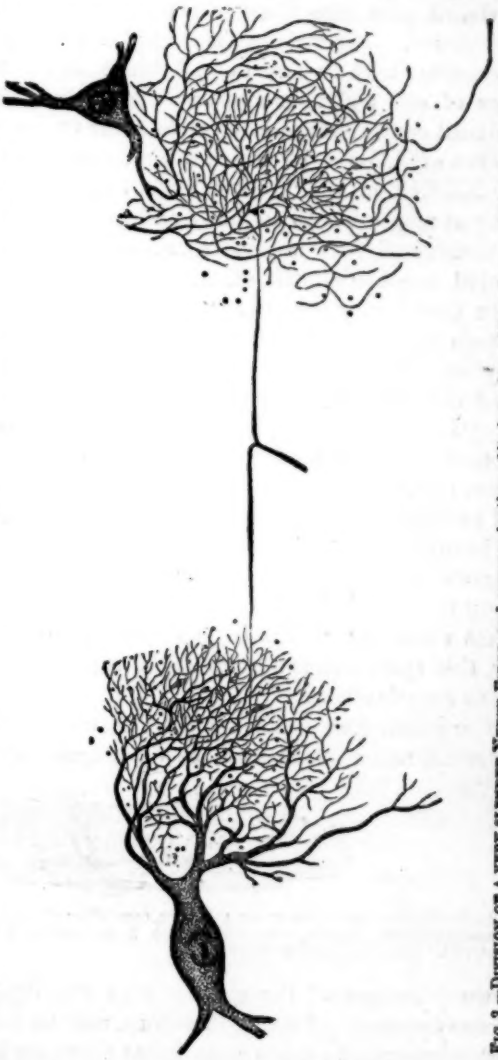

FIG. 3.—DIVISION OF A VERY SLENDER NERVE-FIBER, and communication of its branches with a plexus of fibrils in connection with the much-branched processes of two nerve-cells. From spinal cord of ox. Magnified 150 diameters. (Gerlach.)

On removing a horizontal piece from the upper portion of each hemisphere, the cell-matter of the surface will be found to follow the different windings, while the center of each convolution will be seen to be made up of fibers continuous with fiber-matter in the interior of the hemisphere. Should we cut deeper, we would come upon the corpus callosum, the band of connection between the hemispheres; this body is

composed almost wholly of fibers passing transversely between the two sides; it makes the hemispheres anatomically and physiologically one. Were we to continue our section straight through the middle line of the callosum, we should reach a lateral chamber in each hemisphere. This chamber contains two rather large bodies called the corpus striatum and the optic thalamus. The stems or crura cerebri previously mentioned pass into these bodies before spreading out through the hemispheres. The striatum is shaped somewhat like a pear; it lies in the chamber with its small end forward, and is composed of alternate layers of cell and fiber matter. The thalamus is ovoid, and presents an almost continuous mass of cell-matter traversed by fibers. The researches of J. Luys, of which a condensed account may be found in Vol. XXXIX of the "International Scientific Series," are most interesting as respects both anatomy and functions of the thalamus. Luys has discovered four isolated ganglia of cell-matter in the thalamus, situated one behind the other. He has also traced connections between these ganglia and certain organs of special sense. Behind and between the thalami are two smaller bodies called the optic lobes. They consist of two rounded eminences, the anterior ones being called the nates, the posterior the testes. The optic tracts, forming the optic commissure previously mentioned, proceed from the nates, the testes being connected by a band of fiber-matter with the cerebellum; commissural fibers join these optic lobes with the thalami.

I have now named the leading portions of the cerebro-spinal system, and have indicated their general connections with one another. They are nothing more nor less than a series of nerve-ganglia connected among themselves by transverse and longitudinal commissures. This system shows us matter in its most highly organized condition; further, this system shows us matter in some positive and necessary relation to consciousness.

The conclusions which we draw respecting the nature of this relation must, as has been said, be determined by a comparison of the

FIG. 4.—PORTION OF THE TRUNK OF A NERVE, consisting of many smaller cords wrapped up in a common sheath. (Quain, after Sir C. Bell.) A, the nerve; B, a single cord drawn out from the rest. Magnified several diameters.

known functions of the system with the distinctive characteristics of consciousness. I come, therefore, now to consider the functions of the cerebro-spinal system in so far as these are known, and in so far as they may be inferred from recent experiments and pathology.

FUNCTIONS OF THE CEREBRO-SPINAL SYSTEM.—Nerve-matter has, for its general office-work, to bind together the parts of our body. Wherever this matter is divided there is a peculiar division in the or-

ganism. This division is peculiar, because it does not affect nutrition or the ordinary organic processes. In a limb whose nerves are severed there is a loss of sensation; there is also a loss of movement; the limb continues to live, but for all limb purposes it might as well be dead. Nerve-matter, therefore, preserves the higher bodily unity.

In examining this general nerve-function we discover the distinctive tasks of fibers and cells. The fibers convey, while the cells origi-

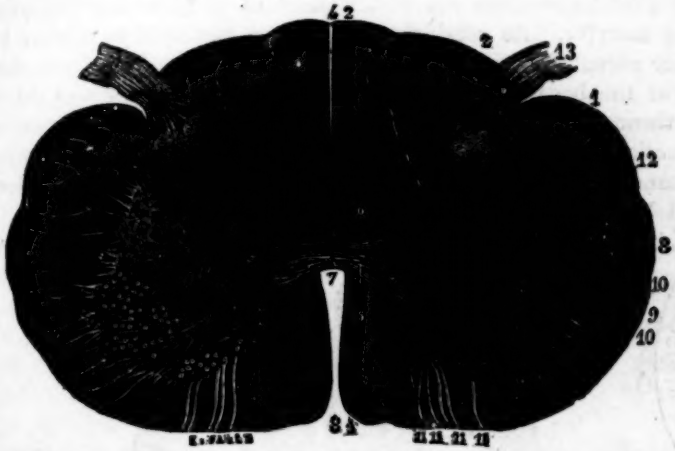

FIG. 5.—TRANSVERSE SECTION THROUGH HUMAN SPINAL CORD IN CERVICAL REGION, showing the organ to be composed of two symmetrical halves. (Sappey, after Stilling.) The black portions correspond to regions containing longitudinal fibers; the lighter portions represent the central gray matter and the horizontal roots of nerves; 5, 6, commissures connecting the symmetrical halves of the gray matter; 11, 11, 11, anterior or motor roots of spinal nerves coming from anterior horns or cornua of gray matter, in which are numerous groups of large ganglion cells; 13, posterior or sensory roots of spinal nerves, entering the posterior horns of gray matter. Magnified about eight diameters.

nate, motions. Fibers may convey motions from without inward, or from within outward; in the former case they are called afferent, in the latter efferent. The nerve-arc is composed of an afferent and an efferent fiber and cell matter. The arrangement of the arc is such that the outer end of the afferent fiber terminates at the surface of the body, the inner end at the cell-matter, while the outer end of the efferent fiber terminates in a muscle, its inner end being also in the same cell-matter. Nothing more than this arc is necessary to produce nerve-action. If an impression be made at the surface of the body, the motion there occasioned is carried by the afferent fiber to the cell-substance; through this substance the motion is transferred to the efferent fiber, along which it passes to the muscle causing muscular contraction. Since the cell liberates motion, and, being much more unstable than the fiber, liberates motion freely, it often happens that a slight impression at the surface is followed by a very violent contraction of the muscle.

Our nerve-arc is not a nervous system. We need only one additional element, however, to form such a system, and this is an ascend-

ing or "centripetal" fiber which shall proceed to another collection of cell-matter. In the cerebro-spinal system we have the lowest nerve-arc brought into close anatomical relation with the large cell-mass of the cerebral hemispheres, as well as with the lower cell-masses, by ascending and descending fibers.

I am now to indicate the functions of the parts of this system previously described, and first the spinal cord. This organ has two distinct functions—these are transmission of motions and independent nerve activity. As conductor of motions the cord is related to the higher encephalic centers. By transmission of motions from the surface of the body along an afferent fiber to the cell-mass of this cord, and thence to the brain, sensations are made possible. By transmission of motions from the brain along efferent fibers down the antero-lateral columns of the cord to the anterior roots, and thence to muscles supplied by these roots, voluntary movements are made possible. This teaching should be emphasized. We are dependent on the anatomical

FIG. 6.—UNDER SURFACE OF THE HUMAN BRAIN. (Allen Thomson.) 1, 1, great longitudinal fissure; 2, 2′, 2″, convolutions of under surface of frontal lobe; 3, 3, 3, prolongation to base of the fissure of Sylvius; 4, 4′, 4″, convolutions of the temporal lobe; 5, 5′, occipital lobe; 6, anterior pyramids of medulla; +, posterior extremity of median lobe of cerebellum; 7, 8, 9, 10, lobules of the lateral lobe of the cerebellum. I–IX. Cranial nerves, all but the first more fully seen in the next figure. The ninth nerve of the right side has been removed. X. First cervical nerve.

integrity of the spinal cord and encephalic centers for any direct sensation, knowledge of things affecting nine tenths of our body, and also for any exercise of volition upon these parts of our body. Consciousness and volition, as far as they relate to any direct connection between ourselves and a large part of our physical organism, are entirely con-

ditioned by nerve-matter, and by the special adjustments of this matter found in the spinal cord. It is interesting to remember, in this connection, that the motions which may be the occasion of sensation are carried to the posterior roots of the cord, while those motions which result in movements are carried to the anterior roots of this organ.

These roots are the crescentic-shaped arrangements of cell-substance before described. The functions of the cord are not limited to transmission. The cord is the source of independent or reflex activities. The peculiarity of these activities is that no consciousness and no volition accompany or occasion them; they are strictly motions. In swallowing food we have an illustration of these reflex activities, and of their close succession to activities that were both conscious and voluntary. Consciously and voluntarily the food is carried to the fauces; at once, the excitation made by the food upon the afferent nerves is carried to the cord and the medulla oblongata; here force is liberated and sent along efferent nerves to the muscular walls of the œsophagus. These walls contract, and the food is passed on into the stomach.

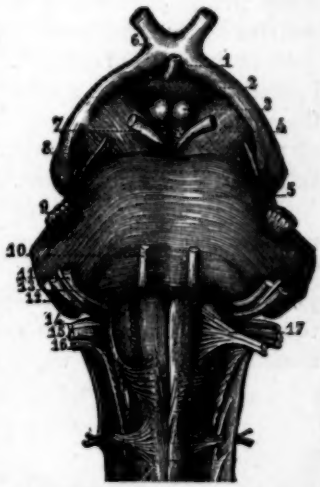

FIG. 7.—UNDER SURFACE OF CEREBRAL PEDUNCLE, PONS AND MEDULLA, SHOWING CONNECTIONS OF THE CRANIAL NERVES. (Sappey, after Hirschfeld.) 1, infundibulum of pituitary body; 2, part of floor of third ventricle; 3, corpora mamillaria; 4, cerebral peduncles; 5, pons; 6, optic nerves, crossing in the middle line so as to form the chiasma; 7, common motor nerves of eyeball; 8, nervus patheticus; 9, trigeminus; 10, external ocular nerve; 11, facial nerve; 12, auditory nerve; 13 nerve of Wrisberg; 14, glosso-pharyngeal nerve; 15, vagus or pneumogastric; 16, spinal accessory; 17, hypoglossal nerve (cut away on one side).

When the cord is broken, those parts of the body which lie below the break will move violently upon irritation, though they can not be moved by any effort of will or be known by any sensation. Many actions, not at first reflex, become so by repetition. Walking is a good example: the movements are learned slowly, and upon numerous efforts; afterward, the work is performed by the centers of the spinal cord, so that walking is really hindered by conscious volition. Dr. Carpenter mentions the case of a shoemaker who was subject to sudden loss of consciousness; at such times he always continued the work he was engaged in when consciousness left him; if walking, he would walk into water or fire; if using his awl, he would continue doing so, frequently to his serious injury.

While this reflex action of the cord may thus take place apart from the brain, the brain exercises a strong inhibitory influence over the action. Some persons, by sheer force of will, can hold their feet still under constant tickling of the soles. The following experiment seems

decisive in the matter: A frog is suspended by the head, and his legs are allowed to dip into a vessel of dilute acid. After some time the irritation causes the legs to be removed. The average time is ascertained by frequent trials—then the animal's cord is cut just below the medulla. The time which now intervenes between contact with the acid and withdrawal of the limbs is much shortened, and the action is decidedly more vigorous. Setschenow's experiments (1863) show that this influence of the brain-centers can be greatly augmented by direct irritation of the optic thalami. The rule respecting the reflex activity of the cord would lead us to expect an increase of the activity upon an increase of stimuli. This is true in general, but Wundt has proved that the rule applies to those stimuli only that are carried to the same part of the cord. If an afferent nerve in some other portion of the body should be irritated simultaneously with the cord, reflex action would entirely cease.

We are now to consider certain activities of the cord which are the most remarkable of all its manifestations. I allude to the experiment first performed by Pflüger. This experiment has been frequently repeated and variously interpreted. Pflüger decapitated a frog, and then placed some acetic acid on the animal's thigh. This headless creature immediately wiped off the acid with the bottom of the foot

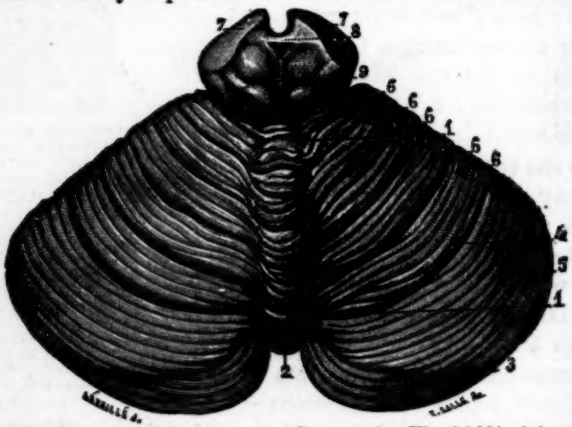

FIG. 8.—UPPER SURFACE OF THE CEREBELLUM. (Sappey, after Hirschfeld.) 1, 1, superior "vermiform process" (middle lobe) whose anterior extremity has been pushed backward in order to show the corpora quadrigemina; 2, posterior extremity of the superior and inferior "vermiform processes," and of the median fissure of the cerebellum; 3, great circumferential fissure; 4, great fissure of the upper surface which divides it into two principal segments; 5, posterior of these segments in the form of a crescent; 6, 6, 6, 6, 6, anterior segment, quadrilateral, and composed of five secondary curved segments like the preceding—each of these segments being composed of closely packed "laminæ" of different sizes, separated by fissures of varying depths; 7, 7, sections of the cerebral peduncles; 8, "posterior commissure" of the cerebrum; 9, corpora quadrigemina.

of the same side. Pflüger then removed this foot and again placed acid on the same thigh. The animal at first, as though deceived, endeavored to rub away the acid in the same way as before. This being impossible, the frog soon ceased trying that method, and seemed to be seeking out some other plan. Finally, he made use of the foot which

was left, and actually succeeded in removing the acid. Pflüger was so astonished and impressed by his experiment that he declared the spinal cord to be possessed of sensory powers—that is, capable of consciousness. I have stated this experiment in detail because it is the most striking among the many facts which have led to such a conclusion as that of Dr. Hammond in his address at Lehigh University, in October of last year. The address may be found in the November number of "The Popular Science Monthly." Dr. Hammond writes, "Suffice it to say that these experiments all go to establish the fact that the spinal cord, after the complete removal of the brain, has the

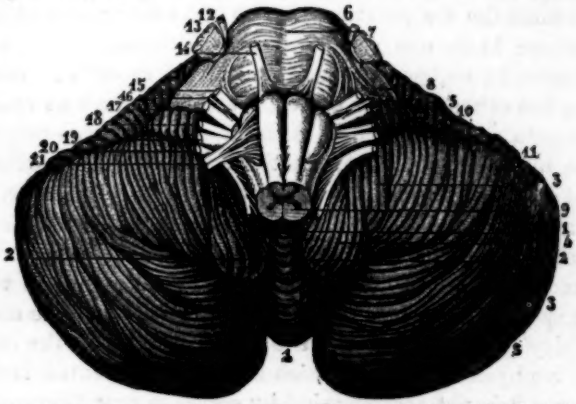

FIG. 9.—INFERIOR SURFACE OF THE CEREBELLUM. (Sappey, after Hirschfeld.) 1, 1, inferior vermiform process; 2, 2, median fissure of the cerebellum; 3, 3, 3, lobes and lobules of the cerebellar hemispheres; 4, "amygdala," or almond-like lobe; 5, lobule of the pneumogastric; 6, pons Varolii; 7, median groove on the same; 8, middle peduncle of the cerebellum; 9, cut surface of medulla; 10, anterior extremity of the great circumferential fissure; 11, anterior border of the upper surface of the cerebellum; 12, motor root of the trigeminal nerve; 13, sensory root of the same; 14, nerve of the external ocular muscle; 15, facial nerve; 16, nerve of Wrisberg; 17, auditory nerve; 18, glosso-pharyngeal nerve; 19, pneumogastric nerve; 20, spinal accessory nerve; 21, hypoglossal nerve.

power of perception and volition, and that the actions performed are to all intents and purposes as perfect of their kind as they would be were the brain in its place." Though Dr. Hammond does not mention Pflüger's experiment, he cites other instances to the same effect. He has seen "the headless body of the rattlesnake coil itself into a threatening attitude, and, when irritated, strike its bleeding trunk against the offending body." Perrault reports that "a viper whose head had been cut off moved determinedly toward its hole in the wall." Neither these instances, nor the others which Dr. Hammond names in this connection, are as striking as Pflüger's experiment. The noticeable feature in this experiment is the fact that the muscular movements which appear upon irritation of the afferent fibers seem not merely to display a *general* conformity to ends, but to adjust themselves to changed conditions. Lotze, remembering the *involuntary* course of acquired movements in man, says, "These actions which point to a consciousness may be simply the back-workings of consciousness upon the mechanism of the reflex organ." Wundt thinks that, "if with Darwin we

acknowledge the inheritance of physical dispositions, we may consider these frog activities as properties of the central mechanism wrought out during the entire development of the species, and inherited by the given individual." That either of these opinions is more reasonable than the one of Dr. Hammond, I think there can be little doubt, especially after witnessing the experiment performed by Goltz in 1869. Goltz took two frogs and decapitated one and blindfolded the other; this was done to prevent any voluntary motions that might arise on account of visual impressions. Goltz then placed both animals in a vessel of water and gradually raised the temperature. Both frogs kept quiet until the temperature rose to 25° centigrade; at this point the frog whose brain was uninjured showed signs of discomfort; as the heat increased he tried to escape, and died at 42° C. During this entire time the other frog sat perfectly still, and gave *no* evidences of distress or pain. But—and here is the significant fact—this same animal, while in the water, made all the reflex defensive efforts when acetic acid was applied to the surface. Aside from these activities, it was still, and died at 50° C. If we admit that the mechanism of the cord possesses the possibility of self-regulation, an admission made by Dr. Hammond in the article from which I have quoted, all these phenomena may be regarded as simple reflex activities. We may accept Dr. Maudsley's judgment that "the reflex activity of the spinal cord is entirely a physical process, which is nowise prevented from taking place because it is not accompanied by consciousness."

Anatomy teaches us to expect complexity of function as we ascend from the cord to the cerebral hemisphere; experiment and pathology confirm our expectation. The medulla oblongata, like the cord, conveys motions to and from the higher centers; further it is the seat of many reflex activities which are indispensable for the organic processes, and further still, it is, in some of these processes, a self-dependent center of innervation. I name the more important activities of the medulla. This organ is the center for respiration. The excitation of this center is brought about in part automatically by the blood. The decrease of oxygen and accumulation of oxidation products in the blood stimulate this part of the medulla, so that respiratory movements may continue after all the afferent nerves connected w th the center have been divided. This respiratory mechanism, though truly reflex, is, to a considerable extent, under the control of the will, thus enabling us to articulate for all forms of vocalization.

The medulla is a center of innervation of the heart. Though the heart will beat if completely severed from the cerebro-spinal system, and, in the case of cold-blooded animals, if removed from the body, still its action is decidedly affected by the fibers which unite it with the medulla.

Again, the blood-vessels are brought under the control of the medulla by the vaso-motor center. The vaso-motor nerves pass by the

spinal cord to the blood-vessels through the ganglia and fibers of the sympathetic system. These nerves, being constantly active, maintain a tonic contraction of the arterial walls.

The medulla is a center for the movements of chewing and swallowing. This center can be excited in a reflex manner, and by the will, but not automatically. There seems to be good evidence that the medulla is a center for combined or co-ordinated movements of the body. Wundt is of opinion that the collective motor-fibers of the body are brought into closer union with each other in this organ. His opinion rests upon the fact that, as long as the medulla is intact, sensible excitations occasion general movements of the body much more easily than when this organ is destroyed.

The question now arises as to the relation between the medulla and consciousness. I do not think we are justified in supposing that consciousness appears in connection with this portion of the nervous system. It is a fact that a frog, having simply the cord and medulla, will react not only in the manner already described, but also by movements of the entire body, away from the source of trouble; the animal may even utter a cry as if in pain, yet he may be "merely a non-sentient, non-intelligent reflex mechanism." We know that the medulla is the last portion of the nervous system to come under the influence of anæsthetics. Persons submitting to severe surgical operations frequently cry out violently, and as if in intense pain; yet they assure us afterward that they were not conscious of suffering.

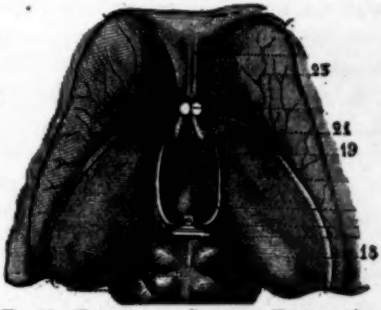

FIG. 10.—THALAMI AND STRIATA. (Sappey, after Hirschfeld.) 18, posterior tubercles of the thalami; 19, anterior tubercles of same; 21, veins of the corpus striatum; 23, corpus striatum.

It is common to cite, as Dr. Hammond has done in the article before mentioned, those human beings who are born without a cerebellum or cerebrum, but who perform such actions as breathing, sucking, swallowing, and crying. In these cases the spinal cord and medulla oblongata are well developed. Why consciousness should be ascribed to the activities just named it seems difficult to understand, especially when we consider that similar activities can be produced by a machine constructed for the purpose. To say that, "if these activities are not indicative of the existence of mind, we must deny this force to all human beings on their entrance into the world," is a singular declaration —what would be the harm of such denial?

Most human beings on their entrance into the world have the higher cerebral centers, yet they are so soft and undeveloped as to make it doubtful whether consciousness even then appears; certainly it does not except in most elementary form. We have now to inquire respect-

ing the functions of the pons Varolii. Section or irritation of this organ is followed by powerful movements, and much more pronounced signs of pain than any previously manifested. If we cut the anterior portion of one side of the pons, movements will be produced on the opposite side of the body, and the vertebral column will bend toward the side of section. It has been shown that the deeper posterior parts of the pons are made up of transverse fibers connecting the two lobes of the cerebellum, and we find, as we should expect, that injury to one side of this portion of the organ causes the same rolling movements as appear upon one-sided injury to the cerebellum.

If we remove all the encephalic centers above the pons, the animal so treated will maintain his upright position, will give cries quite characteristic of pain, and will bring about conjoined movements of flight. These manifestations disappear completely after removal of the pons, and we have left only those reflex activities already shown to be de-

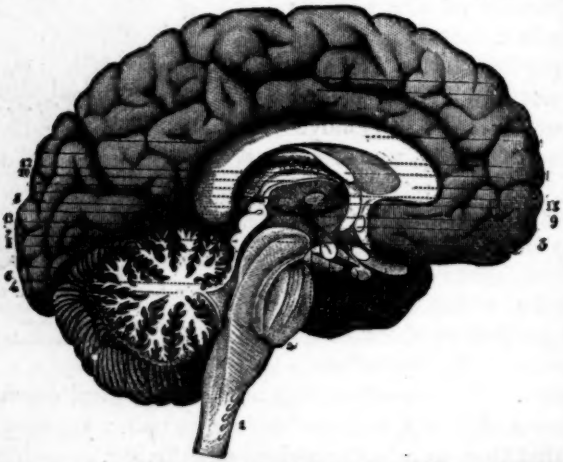

FIG. 11.—LONGITUDINAL SECTION THROUGH THE CENTER OF THE BRAIN, showing the inner face of Left Cerebral Hemisphere. (Sappey, after Hirschfeld.) 1, spinal cord; 2, pons Varolii; 3, cerebral peduncle; 4, "arbor vitæ" of cut surface of middle lobe of cerebellum; 5, Sylvian aqueduct; 6, valve of Vieussens; 7, corpora quadrigemina; 8, pineal body; 9, its inferior peduncle; 10, its superior peduncle; 11, middle portion of the great cerebral cleft; 12, upper face of the thalamus; 13, its internal face, forming one of the walls of the middle or third ventricle.

pendent upon the cord and medulla. It seems clear that in the cell-masses of the pons the movements essential for locomotion, for maintenance of upright position, and for expression of pain, are combined. These phenomena have led many physiologists, among them Longet, to consider the pons as a sensorium commune, or the place where the sensations are assembled, and where the movements caused by sensations arise. Other physiologists, among them J. Müller, believe that the pons is the seat of the power of volition. I would reserve my opinion as to the relation between this organ and consciousness until after the functions of other nerve-masses between the pons and cerebral hemispheres have been considered.

The transverse fibers of the pons Varolii unite the lobes of the cerebellum, and we may appropriately consider the functions of this organ before those of the smaller masses within the cerebral hemispheres. There is, perhaps, no subject in nerve-physiology more obscure and difficult than this one of the functions of the cerebellum. The earlier opinion, that this organ is connected with the sexual appetite, has long since been completely disproved. The special difficulty in determining the functions of the cerebellum arises from the disagreement between experiment and pathology, as also from hazard of injury to adjacent nerve-masses. Flourens was the first to investigate the functions of the cerebellum in a strictly inductive manner; his experiments have been repeatedly confirmed, and they must furnish the starting-point for all future inquiry. Flourens says: "I removed the cerebellum of a pigeon in successive slices. During the removal of the first layers there appeared only a weakness and want of harmony in its movements. On removal of the middle layers, the animal exhibited a general agitation, without true convulsions. It made brusque and irregular movements, and continued loath to see and to hear. On removal of the last layers, the animal entirely lost the power of standing, flying, leaping, or walking, which had been gradually affected by the preceding mutilation. Placed on its back, it was unable to rise. Instead of remaining quiet and immovable, like pigeons deprived of their hemispheres, it was in a continual state of restlessness and agitation, but could never make any determinate movement. It could see a threatened blow, and tried to escape, but without success. It made various efforts to recover its station when laid on its back, but utterly failed to do so. Sensation, volition, and intelligence remained, but the co-ordination of movements into regular and determinate movements of progression was entirely lost." There is no doubt that destruction of the cerebellum is frequently followed by striking disorders of equilibrium. Flourens found, however, that these disorders would, in time, be overcome by the animal, even though the lesions were deep. Upon complete destruction of the organ, the disorders were lasting. Weir Mitchell's experiment, quoted by Ferrier, would not confirm this permanency of the disorders. Weir Mitchell states that he destroyed the functional activity of the entire cerebellum in pigeons who, after some months, recovered "so far as to show only feebleness and incapacity for prolonged muscular exertion, but no real inco-ordination or unsteadiness of equilibrium." Repeated experiments have shown a decided difference of result, according to the character and location of the lesions. If these lesions are made symmetrically on both sides, or if the cerebellum be divided in the middle, from the front backward, there is no important disturbance of equilibrium. If, on the other hand, the central lobe be cut in its anterior portion, the animal tends to fall forward; if in its posterior portion, to fall backward. Lesion in one of the lateral lobes is

followed by a most violent and rapid whirling of the body, the direction being toward the affected side if the injury extends through the entire lobe, but toward the opposite side if the lesion be partial. Comparing these results of experiments with the teachings of pathology, i. e., with diseases of the cerebellum in man, there is an unexpected disagreement. Changes in one of the lobes may occur without any observable symptoms. It is only when there is a thorough wasting of the lobe that we have marked disturbances, and these are not simply connected with movements, they affect the intelligence as well. This fact has been specially noted by Wundt, who refers to the striking example furnished by Combetti's case of the girl Labrosse. This girl was entirely destitute of cerebellum and pons Varolii and yet was capable of voluntary movements, though showing great muscular weakness and lack of intelligence. Bouillard reports the case of Guérin, whose cerebellum was shown to be almost wholly destroyed, "yet the patient could co-ordinate his movements, even being able to walk." It should be observed that in both these cases there was muscular feebleness, shown by the reeling and tottering motions of the persons diseased. It is customary to mention the ninety-three cases collected by Andral, to show that the cerebellum is not an organ for the co-ordination of movements. Professor Austin Flint, of New York, has made a most careful examination of these cases, and has fully established the fact that none of them, save perhaps two, could possibly be taken to have a bearing on the question. Almost all the cases are complicated with diseases in other brain-masses, or exhibit sufficient disorder of movement to confirm the original position. There is a striking fact, first noted by Purkinje, that leads to what seems the most rational conclusion which our present knowledge will warrant respecting the general function of the cerebellum. Purkinje discovered that a current of electricity passed through the base of the head of a healthy person causes dizziness. It is natural to attribute this result to some action of electricity upon the cerebellum, especially in the light of the experiments already described.

FIG. 12.—HUMAN CEREBRUM AND CEREBELLUM, showing the relative size of those parts of the Brain. (After Hirschfeld and Léveillé.)

Dizziness is due to some feeling of change in the relation between ourselves and outward objects. This feeling may be produced by an actual change in the objects or a change in ourselves. Illustrations are abundant, such as rapid riding in railroad-trains or violent swinging. It is a fact of importance in this connection, that alcoholism,

which so constantly exhibits dizziness, is associated with marked disorder of the cerebellum.

In coming to a conclusion respecting the function of this organ, we find that it can not be directly connected with sensation or volition. The sensations appear pronounced and the movements vigorous after destruction of the cerebellum. The marked feature in all deep cerebellar disorders is the maladjustment of muscular actions to the preservation of equilibrium and to harmonious movements. The consciousness of a normal relation between the person and the external world seems overthrown, the violent activities which ensue being plainly attempts to restore this lost feeling. Movements which are voluntarily initiated must be brought into relation with the position of the body in space. The cerebellum is the organ specially concerned with this work. The regulation of all activities that are willed depends upon this feeling of the accustomed relation between ourselves and objects. The cerebellum, in some unknown way, makes the preservation of this feeling possible.

It should be distinctly borne in mind, however, that this conclusion does not necessitate the further one that the cerebellum is itself a seat of consciousness, not even of this consciousness of normal relation. Consciousness may be *entirely* conditional upon the activities of the cerebrum, while at the same time this feeling of relation may depend upon the cerebellum. My meaning is that, though consciousness have its sole physical antecedent in the cerebrum, the special form of consciousness now under consideration may be impossible of origination in the cerebrum without the anatomical and physiological integrity of the cerebellum. Before examining the evidence concerning the functions of the cerebrum, a few words should be said with regard to the optic lobes or corpora quadrigemina, the corpora striata, and the optic thalami. The optic lobes are central organs connected with vision. There seems no sufficient reason to doubt the results of experiment as stated by Ferrier: "The more prominent effects of destructive lesions of the optic lobes in the various animals seem to be blindness, paralysis of irido-motor and some oculo-motor reactions, disorders of equilibrium and locomotion, and in frogs, and apparently in other animals, annihilation of certain forms of emotional expression."

If the higher brain-masses be removed, animals show reflex reactions to rays of light, and, more than this, they display other bodily movements evidently due to the influence of light. According to Longet, birds will follow a burning candle with their heads, and frogs that have been startled into movements of flight by irritation of the skin will avoid objects placed in their way.

These lobes are exceedingly sensitive to electrical stimulation, and the results vary as the electrodes are placed on the anterior (nates) or posterior (testes) eminences.

Stimulation of the nates causes wide dilatation of the opposite

pupil, the head turns in the direction of the eyes, and the ears are thrown back.

When the testes are stimulated, the same results follow, but with the striking addition that, upon the least touch of the electrodes, cries are produced which change from a brief bark to all kinds of sounds as the stimulation is continued.

The opinion has been held by many, and is explicitly stated by Austin Flint, that "the optic lobes serve as the sole centers presiding over the sense of sight, and not merely as avenues of communication of this sense to the cerebral hemispheres." When Flint gives as "posi-

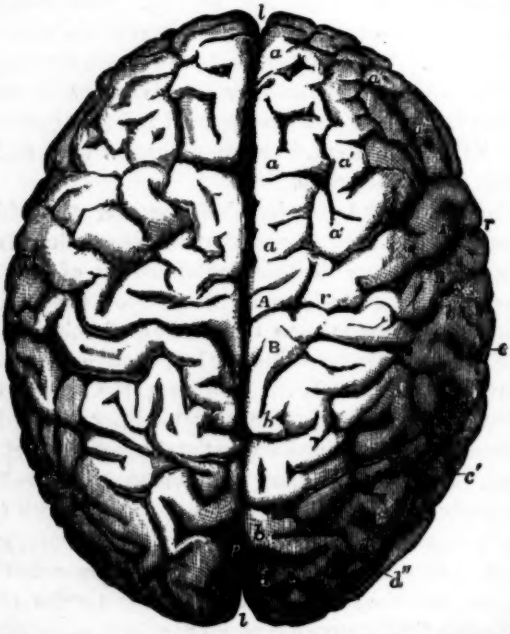

FIG. 13. — BRAIN OF GAUSS, the celebrated Mathematician and Astronomer, upper aspect. (Sharpey, after R. Wagner.) *l. l*, longitudinal fissure; *a*, *a'*, *a''*, upper, middle, and lower frontal convolutions; A, A, ascending frontal convolution; *r*, *r*, fissure of Rolando; B, B, ascending parietal convolutions; *b*, *b*, parietal lobule; *b''*, supra-marginal lobule; *c*, *c'*, first or upper temporal convolution; *p*, perpendicular (or parieto-occipital) fissure; *d*, *d'*, *d''*, upper, middle, and lower occipital convolutions.

tive" proof of his conclusion the statement that "the sense of sight is preserved after complete removal of the cerebrum," he shows how easily it is possible to give, as proof of a conclusion, the conclusion itself. The thing to be determined is, that the actions displayed after removal of the cerebrum are accompanied by any form of consciousness. While it can not be shown that they are not, it is equally impossible to show that they are. The conclusion of Wundt may be the correct one, viz., that these activities are no more designed or conscious than those reflex movements which we know to be produced by the spinal cord.

As to the functions, in detail, of the optic thalami and the corpora striata, hardly anything is known. It will be remembered that these bodies are the rather large masses situated in the chambers of the cerebral hemispheres. There is no reasonable doubt, however, that they are concerned with sensations and motions; the thalami having to do with impressions which are the physical antecedents of sensations, and the striata with the execution of movements. This conclusion is confirmed by pathology. Disease of the striatum is followed by paralysis on the opposite side of the body. Disease of the thalamus, while not always so uniform in its testimony, does still, sometimes, give striking evidence of a sensory significance of the organ. It should be distinctly borne in mind, when speaking of these bodies, that paralysis of sensation and of voluntary motion may be produced by lesions in the cell-matter of the cerebrum apart from any injury to the thalamus and striatum; it should also be remembered that destruction of these basal ganglia breaks the connection between the cell-matter of the cerebrum and the surface of the body, so that the cerebral hemispheres can not perform their functions. It may, therefore, be true, as many maintain, that these organs are not at all directly associated with consciousness, their function being to adjust the connections of sensory and motor fibers with the cerebrum. This general conclusion need not be taken as supporting the fanciful opinions of Luys. Luys believes that in the thalami sensorial impressions "are for the first time condensed, stored up, and elaborated by the individual action of the elements that they disturb in their passage. It is thence that they are launched forth into the different regions of the cortical periphery (cell-matter of the cerebrum) in a new form, intellectualized in some way to serve as exciting materials for the activity of the cells of the cortical substance." According to the same writer, the striata do for our volitions the exact reverse of that which is done by the thalami for our sensory impressions. "It is in the midst of the tissues of the striata that the influence of volition is first received at the moment when it emerges from the psycho-motor centers of the cerebral cortex. There it makes its first halt in its descending evolution and enters into a more intimate relation with the organic substratum destined to produce its external manifestations—in one word, materializes itself." There can be no doubt about the justice of describing this conclusion as fanciful and quite beyond the data.

We have outlined the structure of the cerebro-spinal system, and have stated what may fairly be set down as established concerning the functions of this system up to the cerebral hemispheres. With respect to the presence of consciousness in the parts already examined, it is plain that opinions radically differ. Some maintain that consciousness is not manifested apart from the action of the cerebrum, that all nerve-activities below this organ are reflex, their only distinctions being in the matter of complexity. Others are equally positive that conscious-

ness accompanies all nerve-actions, while still others assert that certain organs below the cerebrum—viz., the pons Varolii, cerebellum, optic lobes—form a sensorium commune where consciousness in some form appears. It is my opinion that this last conclusion has not, as yet, been established or refuted. I regard it as the most rational of the three in the present state of knowledge. If we accept it, we must recognize at the same time a distinction between elementary consciousness and the full consciousness of an intellectual operation. Many facts in every one's experience bear out such a distinction. We are often conscious without knowing the object or occasion of consciousness; being half-aroused, we feel rather than perceive. It is possible, and from the evidence it is even probable, that provision for this rudimentary consciousness is made by the nerve-masses between the medulla and cerebrum.

Whatever conclusion we adopt respecting this matter, the significant fact remains that consciousness is certain to appear in connection with nerve-matter; sooner or later the question of a strictly materialistic interpretation must be faced. After ascertaining the present state of the case with regard to localization of functions in the cerebrum, the induction must be drawn as to the nature of the relation between nerve-matter and consciousness. Grant that this induction shall be more or less a speculation, we need, I think, to remember that all reasoning is speculative, from the nature of the case speculative, and that the only distinction between credulity and reasoning is this, that credulity is both beyond the facts and contrary to the facts, while reasoning is beyond the facts but *according* to the facts.

CHOLERA.

By Dr. MAX VON PETTENKOFER.*

III.—MODES OF PROPAGATION (*continued*).

THE same considerations hold good in India. The famous places of pilgrimage, whose sanctuaries are annually visited by many millions of individuals, always have some cases of cholera among them; but it is only occasionally that an epidemic breaks out, and then it is only at those times when the predisposition to cholera exists—periods, be it noted, which do not for the most part coincide with the time when the number of pilgrims is at its greatest, nor when the principal feasts are in progress. For instance, Bryden has drawn up tables showing the number of admissions into the hospital at Puri in the neighborhood of the sanctuary called Jagganath for the years 1842 to 1866, and these statistics show the number of receptions of cases of cholera

* Reprint of a special translation made for the London "Lancet."

for each month of the year. This journal, extending over so many years, must give a good idea of the frequency of cholera in pilgrimage, even though the numbers be but small. The principal feasts, when the chariot of the deity is drawn over the breasts of the faithful, occur in the middle of March, but the period at which cholera is at its height is in June, when the number of pilgrims assembled is much smaller. Altogether there were three hundred and thirteen cases in March during twenty-five years, while the number was eleven hundred and fifty-five for June—or nearly four times as many admissions for cholera into the hospitals. Puri lies on the southwest border of the territory where cholera is endemic, and has the same rhythm so far as cholera is concerned as Madras. Hardwar lies in the northwest of India, where the chief feast occurs in April, the principal day being the 12th, and often hundreds of thousands of pilgrims, if not millions, stream together here; yet cholera only breaks out in an epidemic form when the regions are predisposed to it. It will be interesting to go further into detail on this question. Hardwar is situated about one thousand feet above the level of the sea, where the Ganges quits the Himalayas, and belongs to the holiest of places which the Hindoos worship. Cholera only occurs occasionally in an epidemic form. In the last century (1783) a severe epidemic was known to have occurred among the pilgrims at Hardwar. From 1858 to 1867 the feasts passed on without the occurrence of any epidemic of cholera, and this immunity was believed to be due to the soundness of the arrangements which were enforced by the Government. In 1867 the whole prophylactic armor was thrown aside. But already in November, 1866, an epidemic of cholera was approaching the neighborhood of Hardwar from Agra. The pilgrims began to arrive at Hardwar on April 1st. On April 3d the majority had assembled, although the stream of pilgrims continued to increase till the 12th. The whole number of pilgrims reached about three million. On April 9th the first case of cholera was detected by Dr. Kindall, and taken into hospital. Other cases soon followed. On April 12th, on holy-day, the pilgrims bathed from sunrise to sunset in the Ganges, in a holy fort which is separated from the torrent of the river by a rail, so that the people could not be drowned. Through this fort there was an incessant movement of men all day long. The water became thick and muddy, partly from the ashes of the dead which the pilgrims had brought with them to strew in the stream, and partly from the washing of the clothes and persons of the bathers. Every time a pilgrim entered the holy fort he dipped himself three times under, drinking the water and saying his prayers. The drinking of the water was never forgotten; if two or more members of a family bathed together, each one drank from the palm of another's hand. All these things happened every year for eight years without ill consequences. But in 1867 a violent epidemic broke out among the pilgrims. Macnamara, a believer in contagium

and in the drinking-water theory, speaks as follows: "On the night of April 11th and on the following day a severe storm burst upon the unsheltered multitude. Only those who know what a storm on the mountains in the tropics is can have any conception what a night of misery these three millions of people suffered on the open plains of Hardwar. This fall of rain must have washed the contents of the closets and the filth on the surface of the earth into the Ganges." And Macnamara believes that on April 12th the pilgrims drank cholera from the Ganges; but Macnamara is wrong. Granted that the storm had really washed the cholera-stools into the Ganges, then the stools must have remained either in the river itself or else in the holy fort, just as was the case in Koch's water-tank. It is true I can find no numerical observations concerning the rapidity of the flow of the Ganges in Hardwar; but if we suppose that its rate is like that of the Seine in Paris at low water—i. e., half a foot per second—then the water would move at the rate of 1,800 feet an hour. The railed-off fort in which the pilgrims bathed is 650 feet long by thirty feet wide, and if the bathing lasted twelve hours, and if only a third part of the pilgrims had bathed, then more than 83,000 persons must have hourly passed through the water; this was impossible, so that only a small proportion of the pilgrims could have bathed on April 12th. These places of pilgrimage are also colossal markets and great places of business. It does not support the drinking-water theory to assume that, during the bathing of the 12th, cholera bacilli did not get into the holy fort from cases of cholera which would hardly be in a condition to bathe, but from cases of diarrhœa. Either a few of the bathers were, to start with, infected, and so large numbers could not be infected until the bacilli had become distributed, or, if a large number were infected at the outset, we naturally inquire where the infection was taken, and whether there was no possibility of their having been infected before going to the bath. While I do not believe that the pilgrims drank death from the holy stream, yet I shall not maintain that the stormy weather had nothing to do with the cause of the epidemic. Cases of this kind have occurred outside India, as in Malta and Spezia in Italy, where a sudden storm has sent up the death-rate in an explosive fashion. But if a weather-storm can create a "cholera-storm," then the cholera must be existent in the soil. One is reminded by this invasion of cholera of the clouds of dust which the watering-carts raise in summer. If the earth is very dry, the water not only lays but makes dust. I can conceive how a sudden heavy fall of rain may rapidly drive out the infective stuff contained in the soil. But Hardwar had experienced bad weather in other years on the same days in April without being followed by such evil consequences.

How does the journey of the pilgrim act in the spread of cholera? That infection can occur in a short space of time is witnessed in soldiers on the march. A case from Bryden's work may be quoted. In

March, 1857, the Sixty-sixth Ghorka Regiment marched simultaneously in two divisions about seventy English miles apart, from the plains to the hill-stations along the Himalayan heights—the A division toward Almorah, the B toward Lohnghat—and both wings, though free from cholera at starting, became infected *en route*. The A division, 611 men strong, arrived on the 13th of March, free from cholera, at Tarai, a narrow strip of land between the plain of the Ganges and the Naini Valley. Tarai is notorious for its fevers and cholera, while the Naini Valley is celebrated for its general salubrity and its remarkable freedom from epidemics of cholera. The division left Tarai the morning after its arrival, passed into the healthful Naini Valley, and halted at the hill-station of Almorah. The first case of cholera showed itself in the Naini Valley twenty-four hours after the first opportunity for infection. The first fatal case occurred on March 16th, two deaths occurred on the 17th, ten on the 18th, nine on the 19th and one on the 22d. These numbers show a mortality of nearly ten per cent. The B division was 361 strong, and passed through Tarai about a week after the A division, remained there but one day, and reached Lohnghat on the 23d of March. The first fatal case occurred on March 21st, while the division was still in Tarai; there were two fatal cases on the 22d, eighteen on the 24th, eight on the 25th, one on the 26th, and one on the 27th. Fatal cases thus occurred within a period of seven days. Such statistical facts, which might be multiplied, have as much value, as direct experiments, as infection through the linen of cases of cholera. It is strange, however, that most of the "cholera linen" first originated in the Naini Valley, in Almorah and Lohnghat, where the disease did not spread further, and where certainly disinfection by carbolic acid or corrosive sublimate was not thought of. But the contagionists have no eyes for such facts. Just as was the case with the Ghorka regiments, so was it with the pilgrims at Hardwar. On April 15th the great mass of the pilgrims—who had been quartered on a flat, partly marshy tract of land, about a square mile in extent, for several days—broke up and departed, so that a stream of 3,000,000 infected individuals for the most part, notwithstanding the influence of the bathing in the Ganges, reeking with filth, began to spread abroad over all India. According to the contagionists, an epidemic of cholera ought to have broken out in every place to which the wandering pilgrims came. In my view, epidemics may break out only where the time and local conditions are favorable; and where these conditions do not exist an epidemic is impossible, as the case of the Ghorka regiments proved. Bryden expresses himself in the following terms on the Hardwar cholera: "From all accounts which have been written concerning the outbreak at Hardwar, the impression is gathered that the epidemic was by no means a typical one. That is only the case, however, if the facts are considered in the light of preconceived theory. For those who search the statistics the facts come out in their true

light, and prove that the type of an epidemic has nothing to do with the smallness or largeness of the number of people affected. The suppression of the cholera at Hardwar toward the east and south and the increase of it in the west and southwest are inexplicable phenomena [Bryden ought to have said, for the contagionists]. But the phenomena are not difficult to understand if the preconceived theory be laid aside. If we take Hardwar as the central point at which the gathering on April 12th was infected, then it will be found that the pilgrims died only in those districts which were reached within a limited time after their daily march had begun. The great majority of fatal cases did not occur at Hardwar, but in those regions which were reached within the first few days after leaving Hardwar. It seems to me that the end of the outbreak at Hardwar was pretty much the same as that of local outbreaks elsewhere, and I can see no connection between the epidemic of cholera in the Punjaub in May and the return home of the pilgrims." The movement the cholera had taken in the autumn of 1866 led Bryden to say, "I believe that the geographical distribution of cholera in 1867 would not have been very different, even supposing that the gathering of the pilgrims had never taken place." And Bryden is perfectly right, for in 1862, for example, the cholera in India became remarkably widely spread without cholera having broken out among the pilgrims at Hardwar.

Such epidemiological facts, which cry aloud for the truth of the existence of local and time predisposition, stand as sure, as etiological elements, as the discovery of a microscopic organism in the intestines of cholera-patients. Only ignorance and prejudice can ignore such facts. It is but a necessary logical conclusion that the comma bacillus, if it have anything to do with the infective material of cholera, must also have some relationship with the local and time conditions which favor cholera. And, further, the relationship must be discovered by the bacteriologists before they can explain an epidemic by the aid of their bacilli and before practical rules can be framed thereon.

Another objection to the views of the contagionists is found in the behavior of cholera on board ships. Long before I announced my views on local conditions, the epidemics of cholera, not only on the rocks of Malta and Gibraltar, but also on ships, were brought as witnesses against my doctrines. What can soil and ground-water have to do with epidemics on ships? And although I had found nothing but confirmatory evidence of my views, still the contagionists remained obdurate. As I can not suppose that all my readers are sufficiently acquainted with my observations on cholera in ships, I must be allowed to give a few illustrations. The contagionists, referring to cases in which epidemics occur during the voyage from Europe and America, say that such can only be explained on the view of infection of one case from another. The facts of such epidemic outbreaks are known to all. How often do such attacks occur? As an instance, I shall

refer to the intercommunication between New York and Europe in the year of cholera, 1873. In that year, according to the register of the offices at New York, there were 760 vessels which arrived from different parts of the world, giving an aggregate of 316,956 individuals, but of these 266,055 came from Europe. Of these, 113,920 came from England, which was free from cholera; from the remainder of Europe the numbers were 152,135, and about 400 vessels served to convey the individuals, making up the last figures, from ports infected with cholera. If we inquire into the statistics, we find that cholera chiefly occurred on four vessels only. Eleven cases were registered from the Westphalia; one fatal case from the Ville du Havre; from the Washington three fatal cases; and from the Holland one fatal case.

Although the chances of contagion aboard ship are very favorable, yet how small was the number of cases of cholera! Take the ship with eleven cases, and we find that they belonged to two German families only; two died during the voyage, nine were landed on Dix Island, and of these but one died and the rest recovered. How is it conceivable that cholera should have confined itself to two families without attacking others? I believe that both families had contracted cholera before going on board; indeed, an epidemic may occur in a ship provided the passengers have all come from a place where cholera exists. The contagionists have, however, replied that some remarkable epidemics have happened on board ship, which could not be explained on the above-mentioned view. It is a question whether cholera can infect on board ship. The contagionists take facts conveniently; they select those instances which occur least frequently and adopt them, to the exclusion of the great majority of instances which tells against them. I recall the articles which I wrote in the "Vierteljahresschrift für öffentliche Gesundheitspflege" and in the "Zeitschrift für Biologie" to prove that I have thoroughly investigated the nature of epidemics of cholera on ships. Rumors of false returns concerning cholera on board ship have been bruited. But these falsifications can hardly be committed when an epidemic occurs during a voyage. It may be said that my instance of 1873 does not disprove the contagiousness of cholera. Cholera, like small-pox, does not attack every one who is brought into relationship with it. If even a few instances of contagion were proved to have occurred on board ship, we should have to admit the contagiousness of the disease.

I do not doubt that instances may exceptionally be found among infectious diseases in which the behavior is essentially the same as that of cholera on the ships going between Europe and New York. But the question is, How do such cases generally, not exceptionally, behave? Vaccinated persons may be brought into contact with cases of small-pox without fear of infection; and, at times, individuals who have not been vaccinated may come in contact with small-pox without taking the disease. As a rule, however, small-pox on board ship be-

haves very differently from cholera. We shall pass in review an instance of a severe epidemic of cholera on board ship, notwithstanding that it favors the views and theories of the contagionists. The following specimen is chosen, for the reason that it occurred on a man-of-war, and as there are many such vessels the advantage of comparison exists: The Britannia was in the spring of 1852 equipped as an admiral's ship, and was generally stationed off Malta for the first year; in August, 1853, it went to Besika Bay, and in October to Constantinople, where it remained the whole winter; and, after the declaration of war, went in March, 1854, to Varna. With the exception of a brief expedition to Odessa and Sebastopol, it remained at Varna all through the summer. In August cholera broke out, and first of all among the troops on shore. The ship and the whole fleet were up to this time perfectly healthy. It was believed that the French had brought the cholera with them from the Dobrudja, whence some regiments had been sent from Varna. A few of these returned, but the majority met with their death either from cholera, typhus, or marsh-fever in the low country of the Danube. After the cholera had begun to subside on land it appeared in the fleet, among which it was, however, unequally distributed. At Varna there were assembled fifty-four ships-of-the-line, belonging to the English, French, and Turkish fleets, without reckoning the smaller craft. The Britannia lay, on August 20th, in the Bay of Cavarna, fifteen miles by water from Varna. About one hundred paces from it were lying two other English three-deckers, the Trafalgar and Queen, both, like the Britannia, manned by 1,040 sailors. The Britannia lost one hundred and thirty-nine from cholera, the Queen and Trafalgar four and six respectively. On the French and Turkish ships it was the same. Strange to say, the French admiral's ship, the Ville de Paris, like the Britannia, was most numerously affected; there were one hundred and sixty-two deaths, of which three were of officers. During the disease the French vessel lay at anchor off the coast with the rest of the fleet. The Britannia went to sea in the delusive hope of staying the course of the disease. That cholera should rage on the Britannia without causing the death of, or even attacking, one of the sixty officers on board, is for the contagionists an inexplicable circumstance. We must now inquire into the reason why cholera was so rife on the Britannia while the Trafalgar and the Queen were so mildly attacked. If the outbreak were due to the presence of cases of cholera, or to the linen from cases of cholera, on the ship, it might be urged that this circumstance was common to all the ships. Dr. Milroy has attempted to explain the epidemic on the notion that it was not due to the specific infective material, but to the individual predisposition to cholera. In the night it was found necessary, on account of the cases of diarrhœa and cholera, to close the hatchways on the lower decks while the ship was at sea. Dr. Milroy says: "The men appeared to be poisoned by the foul air which they had to breathe at night. . . .

A more striking example of the deadly effects of impure air during the period of an epidemic, and of the most infallible means to check the evil, can not be imagined. The immunity of the officers was, on this occasion, unquestionably due to the greater space for breathing purposes which the officers enjoyed." That is an explanation which must satisfy the practical physician. I also believe that impure air is harmful, but I do not think impurity of air sufficient to explain such an explosion of cholera as that above referred to. It must not be forgotten that the Britannia went to sea on account of the general poverty of its hygiene. We ought to inquire into the condition of other ships also attacked with cholera, but in which the hatchways of the lower decks were not shut. My witness, who was on board the Britannia, assured me that the air was by no means so impure as Dr. Milroy made out. Another mistaken notion which I had taken up was also set right. I thought hitherto that the closing of the hatchways of the lower decks was occasioned by the stormy weather. On this point my informant writes to me thus: "The matter was not quite as you seemed to have imagined, and it will perhaps be best if I give a brief description of what actually took place. The day following our departure from Cavarna Bay a calm overtook us, and instead of the desired cool breeze a burning sun poured down on our sick ship. Then there came a swell on the waters, but no wind. In consequence the ship was so violently tossed that the hatchways of the lowest deck, where the crew slept, had to be closed, and then followed the worst night, during which fifty-eight men died, a night without wind, and without the slightest movement of the superheated air. Nothing was said of a storm. If we had but had one! That the shutting of the hatchways had any influence I do not believe; for, owing to the heat, the men were allowed to lie about where they pleased, and most of them betook themselves to the uppermost deck in the free air, and slept on the floor. The physicians had consented to this arrangement, and under the canopy of heaven the bulk of the fatal cases occurred. In this connection it must also be observed that the Ville de Paris, which did not go to sea, yet suffered as much as we did, in spite of the fact that the hatchways were not shut." So much for the explanation which regarded the shutting of the hatchways and the impurity of the air as the cause of the epidemic. The view of the contagionists meets with no better fate. That a cholera-patient should arrive on board with his stools or soiled linen explains nothing, since this circumstance was common to many other vessels without being followed by such consequences. If the infective material were brought in the food and drink on to the Britannia, how is it that only the crew and not the officers suffered? On this point my informant says: "Provisions came daily from the shore, even during the time we were fifteen miles away, but the officers ate the same meat, the same vegetables and fruit as the crew. The only difference was that the crew drank rum-and-water, while the

officers had wine." Thus in the drinking-water no difference obtained. Ballast might have been a vehicle of infection, and for this purpose sea-sand and shingles, and other material, were taken from the shore. But I have been informed that "on the Britannia, as well as other English men-of-war, the ballast consisted only of so-called pig-iron, four-sided pieces, which were wedged together in the lowest part of the vessel, and never touched." We have yet to consider the different habits of the men and the officers while on shore before the outbreak of the epidemic. On this matter my informant writes: "The sufferers, not only of the Britannia, but of the rest of the ships of the fleet, had frequent communication by daily visits with the shore as we lay off Varna, and the crew without doubt betook themselves to those poisonous liquors, and still worse places of pleasure, which had sprung up on shore like mushrooms." It may be understood that the company of one ship would, like men of the same regiment, visit places of pleasure together and imbibe the same drink, and so it might happen that a particular crew visited a certain place where cholera prevailed, while other crews might have unconsciously kept clear of the places from which it is supposed cholera was taken. It remains doubtful whether the infection was derived through the air, water, or food. If these circumstances be viewed in an unprejudiced light, it will be seen that local conditions may account for the infection and spread of cholera on board ships. On emigrant-ships the matter can not be otherwise, and it is necessary, therefore, to inquire into the previous history of those who were taken ill on board. I have shown that the eleven cases of cholera which occurred on the Westphalia, bound for New York from Hamburg, came exclusively from two German families, and that an epidemic as vast as that which befell the crew of the Britannia might be explained, if we supposed that a majority of it came from the same district, or were placed under the same conditions as the two German families prior to their going on board. The exceptional outbreaks on emigrant-ships prove that such an occurrence is possible. That the Britannia, as a ship, was not a place of infection, is shown by the freedom from cholera enjoyed by the sixty officers. These points may possibly be cleared up by the appointment of a commission to inquire into the presence and etiological factors of cholera on board ship during epidemics of cholera. Koch has spoken of the occurrence of cholera on ships, and has attempted to reconcile matters on the basis of his doctrines of contagion. He has studied those ships which ply between North America and Calcutta. This line has not escaped my attention, and I have stated the main facts in my paper on "Cholera in India," 1871. Koch comes to the same conclusions as I did. Of two hundred and twenty-two vessels which made the voyage during ten years, cases of cholera only appeared on thirty-three ships, although they started from a district where cholera is endemic. It appeared to Koch only to be of importance, that cases of cholera continued to occur more than

twenty days on sixteen ships; therefore these cases could not have originated at Calcutta, but must have been derived from infective material on board ship. If cholera is acquired from the infective material on board ship, how is it that the infective matter is, as a rule, so ineffective, and acts only exceptionally? If cholera lasts more than twenty days on board ship, then there must be other causes than those which prevail on land. Let it be assumed that the infective material proceeding from human beings can call forth the disease after the third day and up to the twentieth day. Now, cases of cholera have occurred on board ship as long as forty days after leaving port, of which fact I could give many examples. But these are very exceptional. May it not be assumed that in such cases the infective material might be brought on board and kept effective in some form or other, and that individuals might constantly come in contact with the infecting agent? For exceptional circumstances exceptional causes must be assumed. Properly considered, it will be found that cholera behaves on ships pretty much the same as ague does. When ships leave a malarious district, cases of ague occur on board, but when farther out at sea they cease to occur. As a rule, the illnesses happen only in those individuals who come from shore, though exceptionally the disease shows itself in individuals who have never been ashore. But epidemics of ague have occurred on ships, as Hirsch has recorded in his work on "Malariakrankheiten," where the infection of the crew on shore appears to have been quite impossible, as on a ship which went from an Eastern seaport to England, and yet no one has ventured to say that ague is not dependent on the soil, or that it spreads on ships by contagion from man to man where the people have not been infected on land. The sweat of the sufferers from ague may be likened unto the stools of cholera-patients. If the infectious disease, ague, were as dangerous as cholera, it is not unlikely that many more observations on contagion from cases of fever, and on the presence of ague on ships, would have been made and recorded. Any exceptional occurrence in the way of ague on ships would almost certainly be more likely to be recorded if they happened on men-of-war or emigrant-ships than if they occurred on merchantmen, on the ground that the rare event is witnessed by a large number of men, and because the state of health of men-of-war and emigrant-ships is more carefully registered than is the case with smaller vessels.

A CHAPTER IN FIRE INSURANCE.

By GEORGE ILES.

LAST year was not extraordinary in its fire record. It bore no such calamity in its course as 1871 or 1873, when the nation was called to mourn for Chicago or Boston. Yet there is good reason to believe that during 1884 fires cost the United States $160,000,000. This enor-

mous sum includes estimates of the amounts paid by insurance companies for losses and expenses; of the losses for which there was no insurance; and of the outlay in maintaining fire departments in towns and cities. The devastation by fire during the past year equaled in value the insurable property in, say, so large and wealthy a city as Buffalo. Still more woful than the destruction of property by fire were the sufferings of thousands by bodily injuries, and the losses of hundreds of human lives. Of minor but considerable importance is the prevailing dread of fire which its imminent risk creates—a dread deducting so much from comfort and peace of mind, particularly among the people who work or live in tall and unsafe buildings.

All competent students of the subject are agreed that this tax on life and treasure is largely avoidable—avoidable by care in construction and use of buildings, and attention to tried and proved means of extinguishing fire. The fire-tax is the most onerous one paid by the nation, and it was but natural that the first scientific attempt to reduce it should have been made by a class of capitalists upon whom the cost of insurance was most oppressive.

The textile manufacturers of New England have shown how best the risks, losses, and expenses of fire can be reduced to a minimum. In 1835, when Hon. Zachariah Allen, of Providence, established mutual insurance among the mills of Rhode Island, the rates charged by stock companies varied from 1½ to 2½ per cent. Even at these high figures the business was unprofitable, and the placing of risks often a matter of difficulty. Within the fifty years since 1835, the cost of insurance to the factories of New England has been reduced to two-sevenths of one per cent. This, too, while the ordinary rate of insurance throughout the United States is nearly one per cent on property considered to be on an average less hazardous in character. I will endeavor to state how this result has been brought about.

Principally by full inquiry into the causes of mill-fires, which has shown that the three elements of safety are good construction, adequate quenching apparatus, and thorough discipline in its use. Safe construction can not always claim the much-abused term "fire-proof," but it may be practically the same thing, "slow-burning." It need be but little more expensive than the customary bad methods, and proceeds on a few simple rules:

1. Timbers for the frame of both floors and roofs should be made in such solid manner as to burn slowly; all should be open, smooth, with the corners chamfered off.

2. Floors and roofs should be of thick plank, with mortar or sheathing-felt between the planks and boards of floors. No boxed, hollow cornices should ever be constructed.

3. There must be no concealed space under a door, behind a furring, or in a partition, where a fire can lurk out of the reach of water, or where a rat or mouse can build a nest.

4. Elevators, stairways, and other openings from floor to floor should be cut off by properly constructed hatches, doors, or other means, automatic in action, if possible.

5. Openings in party-walls and exposed windows should be protected by wooden doors or shutters, covered with tin, preferably self-acting.

6. Rooms in which special danger exists should be plastered on wire lathing close to the surface of the ceiling, and following the line of the timbers. All iron posts in exposed places, or iron or stone posts, on which the safety of a building greatly depends, should be protected from fire, either with wood or tin, or by wire lath and plastering.

Of materials for walls, brick is best, and sandstone next best. Limestone calcines and crumbles at high temperatures, and granite breaks and cracks most dangerously. When gas is used in lighting a mill, it is proper to have a controlling valve external to the mill, so as to cut off the supply in case of fire. Sometimes gas is carbureted with gasoline, in which case, fifteen minutes before a mill ceases work at night, the uncarbureted gas is alone permitted to be used, so as to take up any liquid deposited in the pipes. When electric lighting is adopted, approved rules for its installation and use must be observed.

Whenever possible, mills should not exceed one story in height. When so constructed, they can be better lighted than lofty buildings, and they are much less liable to costly vibration. This latter source of loss in a mill four or five stories in height may absorb a fifth of the motive power. A one-story mill, in case of fire, is much more safe and manageable than a lofty structure. It is pleasant to find so potent economic arguments against the tendency which, in recent years, has piled up factories so high, and crowded them together so closely.

Steam-pipes, for heating purposes, have been found quite as effective when suspended from the ceiling as when placed upon the floor; while, in the former case, they do not furnish lodgment to cotton-waste, paper, shavings, and other combustible material. Similar refuse is apt to gather dangerously about a steam-pipe rising through a floor —the means of safety here being its inclosure in a cast-iron shield of conical form. Steam-pipes require careful protection from contact of inflammable substances. Of non-conducting covering materials, asbestus, hair-felt, cork, fossil-meal, magnesia, and rice-chaff are the best.

The rules here presented in mere outline are given in detail by Mr. C. J. H. Woodbury, inspector of the Boston Manufacturers' Mutual Insurance Company, in his work on the "Fire Protection of Mills." They are the outcome of the long and varied experience of the Mutual Companies of New England. Of these companies, the one I have just mentioned is the foremost, and I am indebted to its president, Mr. Edward Atkinson, for data included in this sketch. From an analysis of the causes of fires in which his company was interested

during the twenty-nine years ending January, 1880, it appeared that spontaneous combustion had played a leading part. Cotton-waste, saturated with oil, and used for wiping machinery, then carelessly cast into wooden boxes and cupboards, had clearly led to immense losses. Losses quite as serious were traced to the firing of similar materials secreted by rats and mice. This suggested an exhaustive inquiry into the spontaneous combustibility of the oils in common use as lubricants, the Massachusetts Institute of Technology lending its aid in the work. Astonishing were the results—certain popular oils were proved so hazardous that the mills using them had been unknowingly courting calamity. Other brands were found comparatively safe, and a few quite safe. A rule was then adopted by the Mutual Companies prohibiting certain oils from use, and recommending certain others. Generally, mineral oils were approved, and animal and vegetable oils condemned.

The benefit of the inquiry did not cease here, for it suggested to Mr. Woodbury a series of experiments whereby he has determined the value of oils as lubricants. Since friction is one of the main sources of expenditure in the use of motive power, and a noteworthy cause of fire, Mr. Woodbury's reduction of lubrication to a science is a valuable gift to manufacturing industry. His researches were presented to the American Association for the Advancement of Science at its meeting in Boston in 1880, the published proceedings giving his results in full.

Oil is not only a lubricant, and a substance liable to spontaneous combustion, but has an extensive application in wool-manufacture. One of the collateral inquiries instituted by the mutual underwriters on behalf of their clients has led to an immense saving in wool-oils through the exact determination of their comparative efficiency.

Spontaneous combustion, according to Mr. Atkinson's compilation, was shown to occur not only with respect to oil and charred wood, but also in dyeing operations. Certain kinds of coloring-matter enter rapidly into combination with atmospheric oxygen, and reach a dangerously high temperature. Fans employed to produce a strong air-blast aggravate this danger, against which the best safeguard is the use of fusible links melting at 160° Fahr. Thus fan and engine can be automatically disconnected when fire breaks out. Lanterns have to answer for many conflagrations. In the Boston Manufacturers' Company alone, lanterns broken and upset have led to losses aggregating a quarter of a million dollars. Safe types of construction were introduced, soon after the need for them was announced. Another preventable cause of loss came from employing solitary workmen on repairs at night. In cases of fires spreading from sparks, lanterns, cinders or other source, the unaided mechanic could not well exert himself at once to give the alarm and quench the flames. Hence the enactment of a rule that at least two workmen shall execute all repairs

necessary when mills are idle. One of the workmen must be capable of starting the fire-engine and pumps instantly. Most fires occur at night. At other times when work is suspended, and supervision apt to be relaxed, the risk of fire increases. To meet this, comes the obvious suggestion that on Sunday, Independence-Day, Thanksgiving, and Christmas, there should be increased vigilance by superintendents and watchmen.

However wisely designed a mill may be, and however vigilant its employés, it may take fire from causes practically unavoidable.

How flame may best be quenched then becomes the next important question. Apparatus for extinguishing fire, according to the Mutual underwriters, should include :

1. In all possible cases, water-pipes supplied from at least two sources, with two or more fire-pumps ; or one pump and a reservoir of sufficient elevation to give an ample supply of water through its connecting pipes.

2. An adequate pipe-service with hydrants in yards, porches, in all rooms, and upon the roofs. When possible, the water should stand in the hydrants, both in the yards and in the building, from the tank or reservoir.

3. Hose and hose-pipes should be ready for use, and should be attached to the hydrants, with a drip-coupling to take off any water that may leak by the valve.

4. Automatic sprinklers in all parts of a building where there is special liability to fire, and generally in all stories above the second, however occupied, especially the uppermost. Among the appliances of recent introduction for extinguishing fire, the automatic sprinkler deserves special mention from its importance and success. It mainly consists in a plug of fusible metal attached to a water-pipe, which melts off at a moderately high temperature, say 160° Fahr., and permits the issue of a drenching spray. Were not high cost a serious objection, sprinklers might be made controllable, not by fusible alloys, but by electrical levers attached to sensitive thermometers. Any device which shortens the time during which a fire is left to itself is of importance. A fire-alarm is usually applied to the existing automatic systems.

5. Small hose attached at numerous points to the water-pipes in the rooms.

6. A full supply of water-buckets reserved for fire purposes, and always kept full.

For the efficient use of apparatus, a well-drilled fire department is required. Watchmen particularly should be thoroughly trained in the use of appliances for combating flame, and should be familiar with the positions of valves, hose, and buckets. Aid in their work is given by an excellent electric fire-alarm, which is gradually coming into use in the mills of New England. It announces instantly, in both engine

room and office, the point at which a dangerously high temperature or fire exists.

For the protection of city blocks, a system of hydrants and pipes placed on roofs has been suggested; water at an ample pressure to be constantly available. Very solid brick division-walls, carried up a few feet above the roof, are desirable in such blocks.

It may now be in order to state the progress of the mutual system of underwriting, whose methods have been briefly presented. On January 1, 1885, the nineteen associated Factory Mutual Insurance Companies had at risk no less a sum than $375,000,000, an amount nearly twice as large as that at risk seven years before. During these seven years the cost to the insurers in the leading company, the Boston Manufacturers', had declined twenty-three per cent, as compared with the cost during the years from 1850 to 1878. In the early part of this latter period the volume of business was small, and the losses proportionally greater than they afterward became. During 1884 the net premiums paid by insurers in the Mutual companies averaged 28·28 cents per $100 insured.

A few words as to the details of effecting the mutual insurance of factories: Although the cost is currently but 28 cents per $100 per annum, the companies charge rates averaging 80 cents, the difference being returned as dividend. In addition to the payment of premium, each insurer becomes liable for an assessment five times as great as the premium. No such assessment has ever been called for in the history of the Factory Mutual Companies. No policy is granted until compliance with the companies' rules for construction, quenching apparatus, and discipline in its use, has been ascertained by an inspector. His further business is to pay frequent and unannounced visits to insured premises, to see that all is as it should be. Disobedience to rules, or culpable negligence, may be deemed sufficient cause for canceling a policy. When an ordinary mill or factory adopts the means of safety laid down by the mutual underwriters, it is computed that the outlay is saved in premiums in two years.

In the foregoing paragraphs a form of scientific underwriting has been briefly described, which has important bearings on the general question of insurance and the reduction of the fire-tax. New England Mutual underwriters have ample scope for their activity in the pursuit of their business, and are very cautious in pointing any morals to stock-insurance companies. Mutual underwriting is well adapted to the kind of risks it accepts. These are large mills usually isolated. They fall into comparatively few classes, for which rules for construction and fire-appliances can be readily prescribed. Each passing year finds manufacturers more and more alive to the advantages of the mutual system, the last interest which has begun to adopt it being that of the rubber-factories.

Mutual underwriting can not be directly applied to the miscella-

neous and concentrated risks by great cities. It shows a long and honorable record without the levy of a single assessment. Yet what owner of city property, with Boston and Chicago in his memory, would care to become liable for fourteen times the net premium of a normal year?

While the direct extension of mutual underwriting has recognized limits, still its methods afford lessons of utmost value not only to owners of buildings, but to architects and builders. Stock-insurance companies usually accept risks as they find them, and base the rate of a premium on the assumed degree of combustibility. Mutual insurance has taken its chief mission to be the prevention of combustibility, by a judicious co-operation between owner, architect, and builder. It has demonstrated that this co-operation accrues greatly to the owner's advantage in money saved and safety increased. The cardinal principle of mutual insurance is to minimize risk by a strict examination into the causes of fires. This rule should be carried out in every city and town of the Union, by properly appointed officers, clothed with necessary authority. It matters not how petty a blaze may be—its investigation may yield information of immense value. An unsuspected source of danger may to-day burn ten dollars' worth of property, and next month consume a million. An electric current crossing water rendered conductive by a trifling chemical admixture; fine flour-dust diffused in a mill; sparks struck by a wheel or tool of metal—these are among the hazards for which special safeguards have been devised and applied within recent years. There is nothing strange about these hazards, now that they have been pointedly brought into notice. They were simply common neglected matters, until overwhelming disaster showed the necessity of prevention. In small fires or great, investigation into causes should be thorough, that means of safety, if such exist, be ascertained and enforced. Mr. Atkinson is of opinion that fires not preventable need not cost more than one tenth of one per cent per annum of the value of property insured. All beyond that, he holds to be the price of faulty construction, inadequate appliances, and imperfect discipline in their management.

While mutual underwriters have been exploring the essential principles of sound construction, they have arrived at much as applicable to warehouse or hotel as to cotton or paper mill. They have pointed out the risk of gingerbread cornices, hollow floors, and high-pitched roofs. They justly inveigh against the common practice of setting pine Mansards on lofty structures. They give instance after instance where solid party-walls and self-closing hatchways have saved property, by holding a fire within manageable bounds, and keeping it in a horizontal area, where it can be successfully fought. They have determined the best appliances wherewith to combat flame, and how they can be best placed and used. An important principle in the construction of these appliances has been evolved as a result of their labors—

the principle whereby, on the first bursting out of flame, automatic means of safety begin their work. Developed fully, this principle promises to be the most effective known against the incendiary, whose crimes lead, perhaps, to one third the losses by fire. A watchman usually vigilant may be unobservant or negligent at a critical moment. The melting-point of a soft alloy, or the transmission of an electric current, has a constancy which may be depended upon. Fusible links which stop a destructive air-blast, or close a door, window, or hatchway, fusible plugs which control powerful streams of water, are excellent substitutes for apparatus to be started by human agency on detection of danger.

That insurance has increased incendiarism is proved by British statistics. Between 1852 and 1866, the proportions of fires originating in Great Britain from unknown causes rose from 34½ to 52½ per cent. Destruction by fire takes place in a much larger proportion in property insured than uninsured. Incendiarism is of two kinds, that of an interested policy-holder, and that of a malignant criminal. While fires due to the latter may be checked or extinguished by well-planned apparatus, the losses due to the former variety of crime might be to some extent prevented by insurance companies only indemnifying for losses in part. Suppose a merchant to take out a policy by which he is to be reimbursed for three fourths the amount of a loss actually sustained, whether partial or total. Clearly, the company has a better risk than if it granted full indemnity, for now its client has a direct interest in escaping loss by exercise of skill and vigilance. Any means which makes responsibility reside with an owner has a wholesome element of justice and safety in it. Very unbusiness-like certainly is the action of some stock companies which refuse to reduce a premium rate when the insured adopts new means of safety. Such refusal would warrant the impression that any methods whereby the volume of loss by fire would be diminished, and with it the commissions and fees of canvassers and agents, have a sinister interest to oppose them.

The cost of insurance is chiefly due of course to losses; about one half as great, however, are the expenses of the business. Let us turn once again to mutual underwriting for instruction. That system, being uncompetitive, requires neither advertisement nor solicitation. Its expenses are one tenth those of stock insurance. The mutual companies are simply the agents of their policy-holders to provide means of collecting the sums paid for indemnity and the small charges of the business. Stock companies founded, say, in New York, Hartford, or Philadelphia, have agencies throughout the country, actively competing against one another for business. Small cities have often as many as twenty insurance agencies, maintained at high expense in proportion to the volume of transactions. Economy here could be effected by a single local company without agencies, doing as much local

business as it could, and reinsuring a large percentage of its risks in the offices of other cities. By a uniform method of classification, and a uniform responsibility, each of the nineteen New England Mutual Companies reinsures in the other associated concerns. The acceptance of risks is local, their distribution is general. Were pioneer stock companies to adopt this plan, their success would oblige other companies to imitate them. Expert underwriters would be required to plan the details of a scheme applying to miscellaneous risks some principles of mutual insurance. These would comprise:

1. The identification of the interests of owners and insurers by basing rates of premium upon the actual hazard, allowance being made for all precautions against fire, and approved methods of quenching it. By issuing policies to cover somewhat less than the total of a loss, at a lower rate than when full indemnity is assured.

2. By combination of the advantages of a local underwriting with the benefits of well-distributed risks. Companies doing a local business are not subject to the expenses and inefficiency of great companies with agents widely scattered and difficult of control. Reinsurance on a well-considered method will give local companies stability in cases of large fires—this, while the interests of local insurers will always be large enough to make them anxious to have as few and as small fires as possible.

In a large city, where several local companies might occupy the field, each could select its risks from among all quarters of the city. By whatever means attained, one thing is clear, that the business public, pressed by the narrowing margin of profit, will avail itself of the cheapest safe insurance to be had. The reduction of cost must spring from making the prevention of fire the cardinal rule of insurance. At present the main rule is simply to accept risks as they are, and assess immense losses—largely preventable—on the public. In Great Britain, premiums average one quarter those charged in America, and the business is profitable. Why can not America reach this economy, by adopting British care in construction?

Apart from the Manufacturers' Companies, mutual underwriting has not obtained much foothold in the Union. In New York State, in 1883, the assets of the mutual companies were but one per cent in amount of those of the stock concerns. These latter, with large reserves ready at the call of disaster, enjoy a public confidence withheld from the comparatively weak mutual associations, scattered here and there throughout the country. When capitalists, however, become local underwriters on a large scale, we may expect insurance to have a preventive efficiency, such as we find among the New England mills. Just here a quotation from the New York State Insurance Commissioner's last report may be in order:

"During 1883, stock companies doing business in the State lost percentages of premiums received as follows: Those organized in the

State, 45·83 per cent; those organized in other States, 64·06 per cent; and foreign companies, 66·03 per cent." The ratios of expenses parallel these proportions. So much for the saving power of direct interest and control.

The prevalence of wood in American building, arising from its cheapness, has had its effect in promoting combustibility. We are accustomed to hear frequent lamentations of the destruction of our forests. That destruction will bear at least one benefit in its train—a lessened use of wood in building. In European cities, where brick, tiles, and cement largely take its place in construction, fires are infrequent, and not specially devastating. There fire departments may be found in a simplicity which argues an enviable feeling of general security. As lumber grows scarcer from year to year, and money cheaper, we may expect a decreasing combustibility in American buildings. Immunity from loss is bought at its lowest price when a structure is designed and erected with intelligence and liberality; these qualities will have more scope as capital grows more abundant.

In developing sound principles of insurance the mutual underwriters of New England have done notable work. Their inquiries have been marked by a thoroughly scientific method, which has in its range generously included collateral investigations of immense economic value. In the strict line of their researches, while applying justice, economy, and ingenuity to the solution of their problems, they have taught lessons that must produce world-wide good. Their conscientious work, when understood and applied, will inevitably lower the fire-tax, save life, and abate one of the chief horrors of our civilization.

CUMBERLAND SOUND AND ITS ESKIMOS.

By Dr. FRANZ BOAS.*

SINCE times long ago ships have been yearly going out from their native ports in pursuit of the whale. The vessels of the ancient Basques, and the fleets of the Hanse cities, of the Netherlands, and of

*Dr. Boas spent about twelve months, from August, 1883, till the 25th of August, 1884, in exploring from his headquarters, at the Kikkerton Islands whaling-station, the coasts of Cumberland Sound and Davis Strait. Though he was prevented by the changes of the weather, and an epidemic that raged among the dogs, from accomplishing as much as he had contemplated, he made numerous explorations in Cumberland Sound, and followed the western coast-line of Davis Strait as far as Cape Raper in latitude 69° 50′ north, traversing in all his journeys nearly 2,400 miles of country, most of which had been previously unexplored. He learned the language of the Eskimos, and acquired much interesting information respecting their customs, traditions, and religious observances, some of which are presented in this article. The sketches have been furnished us by the author in slips of the "Berliner Tageblatt," and have been translated from the German for "The Popular Science Monthly."

the Norwegians, enticed by the lucrative pursuit, eagerly pressed forward into the dangerous frozen sea. Enterprising sailors were constantly opening new hunting-grounds to the fishers, some of which are still frequented by whale-hunters. Besides the East Greenland Sea, Baffin's Bay and Davis Strait were among the best-known hunting-grounds, and were visited every year by fleets of Scottish and American whalers. In May, the ships leave their home ports and sail in the toilsome and dangerous route along the west coast of Greenland, toward the north, to reach the fishing-ground in the east and south-east of Lancaster Sound. The whales resort to this region in the latter half of July, while later, after the broad girdle of coast-ice on the west side of Davis Strait has broken up, they go farther south.

When the whales had become more rare here, in the fourth decade of the century, the brave William Penny, who afterward distinguished himself in the expeditions in search of Franklin, determined to seek for new and richer fields, and penetrated into the half-forgotten Cumberland Sound, whose waters were numerously populated by whales. As he was accustomed to have frequent dealings with the natives, friendly relations were soon established between the inhabitants of the sound and the whalers; and, although Penny desired to enjoy his new discovery all to himself, he was shortly followed by an enterprising American captain, and the rich fishing-ground he had found was no longer the secret of one man. As early as May and June, when the ice breaks up in the sound, many whales appear at the floe-edge, and were pursued by the natives in their skin-boats. But, as the entrance to the sound was closed at this season by the heavy and broad pack-ice, it was not supposed that any advantage could be taken of this fact till a shrewd captain thought of wintering over two boats' crews, so that they could begin the chase early in the spring. These crews were not very strong in numbers, and they added to their force by enlisting Eskimos, who gave their services readily for a little pay. The experiment proved profitable, and was followed by several ships, till Cumberland Sound became lively in both summer and winter. Other factors preferred to send out their ships only once a year, leaving their men to live in houses which were prepared at home and set up on the fishing-grounds. The whales were pursued without mercy, and have accordingly diminished so rapidly that the region, which had for a short time witnessed the most lively activity, has been deserted by nearly all the ships. Only a few scattering graves now remind us of the time when the stir of enterprise prevailed here.

Two stations are, however, still kept up. They continue to follow the custom, established in the beginning, of employing Eskimos and manning the whale-boats with them. It appears that the sound, at the time it was first visited by the whalers, was inhabited by about two thousand Eskimos, but they have diminished since then with really frightful rapidity, till now they hardly number three hundred

persons, who are distributed among seven settlements. The Kikkerton Eskimos, who alone once manned eighteen boats, representing a population of about four hundred and fifty heads, now number only eighty. The two fishing-stations are situated on Kikkerton, an island on the east coast of the sound. When the Eskimos who have spent the summer up the fiord return at the beginning of October, they eagerly offer their services at the station, for they receive in payment for a half-year's work a gun, harmonicum, or something of the kind, and a ration of provisions for their families, with tobacco, every week. Every Saturday the women come at the blowing of the horn into the station-house, to receive their bread, coffee, and sirup, and the precious tobacco. In return, the Eskimo is expected to deliver a piece of every seal he catches into the kitchen of the station.

The time for the fall catching commences as soon as the ice begins to form. If the generally stormy weather permits it, the boats leave the harbor to look out for the whales, which are accustomed to go along the east coast of the sound toward the north. During the last years the catch was very unprofitable, for only a few whales were seen. As the ice forms very quickly, the boats must be brought back to the land by the end of October or the beginning of November. Since whales have become scarce, the stations have followed the business of collecting seal blubber and skins, which they buy from the Eskimos.

A lively traffic springs up as soon as the ice has become strong enough to allow sledges to pass from shore to shore. The sledges of the stations are sent from one settlement to another, to exchange tobacco, matches, coffee, bread, etc., for skins and the spare blubber which the Eskimos have carefully saved up. The natives themselves, who need useful articles like cooking-pots, lamps, etc., collect quantities of hides and blubber, and come to Kikkerton to supply their wants. Eskimos come over from the southern part of the west coast of Davis Strait to exchange bears' skins for articles they want. The winter passes quickly away amid this stir of business, till everything comes to a stop in April. For now the seals cast their young, whose white, long-haired skin forms an important element in the clothing of the people. As the hunting-season only lasts a month, the natives put the time to a good use; and the old settlements are quickly deserted, for the seals are to be found most abundantly in the fiords and among the rough ice, which are the least productive places in winter.

When the sun has reached such a height that the snow begins to melt in favored spots, a new life begins at the station. The skins which had been collected in the winter, when frozen, are brought out of the store-room and exposed to the beams of the sun. A number of Eskimo women busy themselves, with their half-moon-shaped knives, in cutting the blubber from the skins and putting it away in tubs. Others clean and salt the skins, which are likewise packed away. The men also find enough work to do after the catching of the young seals

is over. The whale-boats must be got ready for the spring fishing. New Eskimos, who have been engaged by the station for the next month, come down daily, with their families and all their goods, to take up their abodes at Kikkerton. The boats are dug out from the deep snow, the oars and sails are looked after, the harpoons are cleaned up and sharpened, and everything is in busy preparation. The boats are made as comfortable as possible, with awnings and level floors, for their crews are not to come to the shore again for about six weeks.

By the beginning of May, the arrangements having been completed, the boats are put upon the sledges, and, under the direction of native drivers, are drawn by dog-teams, with their crews, to the edge of the ice. The sledges being heavily laden, and food for the dogs having to be provided by hunting, the day's stages are short. Arrived at the floe-edge, the sledges are unloaded and the boats are launched. Here is a profusion of seals and birds of all kinds, and the chase is opened without delay upon everything that is useful and can be shot. Sledges are regularly sent back to Kikkerton with skins and meats for the families of the Eskimos, while the blubber is packed in tubs which are kept ready on the spot.

The most important object of the expedition is the whale. Harpoons and lines are always in readiness for the contest with the mighty monster. The whale-fishery has been so often described that I pass over the already well-enough known details of the exciting chase. The peculiar circumstances in the sound give to the capture here a character which is exhibited in no other region. The boats go back to the north with the breaking up of the ice, and the fishing closes in July. The Eskimos are paid off and dismissed, and resume their reindeer-hunting, while the whites are glad to enjoy some rest after weeks of exhausting labor.

Unless the results of the whale-fishery improve within a short time, the period can not be far distant when the last of the whites will abandon the unprofitable land. Then the Eskimos, who can no longer live without powder and shot, will be compelled to remove from the sound and make their home on the shores of Davis Strait, which is visited every year by ships; and Cumberland Sound may, perhaps, become more desolate than it was before its apparently inexhaustible richness in whales attracted whole fleets to its waters, and gave the region an important place in the world's trade.

When our ship, the German schooner Germania, was about to enter the port of Kikkerton in the summer of 1883, there came a boat-load of Eskimos to offer us their help. I had not formed a good opinion of the appearance of these people, but I was really astonished at the figures I saw. The little bandy-legged fellows who ran laughing and chewing over the deck of the vessel, with their long black hair, flat faces, and dripping eyes, made an extremely repulsive impression; and when we were visited by a boat-load of women, among whom were a

few antiquated matrons, my aversion toward my future fellow-residents reached its highest point. It really seemed as if the ugliest of the ugly had been selected to receive us, for I was afterward surprised by many a cheerful and pleasant face, or a strong, well-built figure. These first Eskimos appeared at least relatively neat, for they had probably held a grand feast of purification before the arrival of the ship. I had an opportunity to observe what a good influence intercourse with the whites had had upon the natives, when I came into a settlement on Davis Strait, which had never been visited by a European. I would not undertake to describe the appearance it presented, so odious was it. When I related to the Eskimos of Cumberland Sound the unhappy experiences I had suffered in the oily and filthy huts of this tribe, they answered: "We are like the cleanly gulls, which have, indeed, to look to the oil and fat of seals and walruses for their food, but still keep their feathers tidy; but they are like the Mollimoke, which wallow in blood and fat, and do not mind any kind of dirt."

The fur dresses of our Eskimos appear to be well made, and adorned with trimmings of different kinds of skins. Particular attention seemed to have been given to the reindeer-skin jackets of the women, with their long tails reaching to the ground, and to the wide hoods in which the children are carried. The short breeches reaching to the knee, of white seal-pups' skin, were very handsome. Afterward, when I became better acquainted with my new friends, I perceived what a disadvantage an indolent woman could be, even in this country, when she can not or will not keep up with her household duties. The clothes of the family too often bear witness to her neglect, and I have sometimes pitied the poor men who have to go to their seal-hunting in cold winter weather, without enough clothing. Among the first women who visited us were some unusually adorned with a cotton garment, which was occasionally exposed under their fur jackets. The men also appeared to be well clothed in seal-skin jackets, small hoods, and breeches ornamented with variously colored furs. Their long hair, loosely fluttering about their heads, gave them a wild appearance; but their quiet eyes, and the childish pleasure they exhibited on every opportunity, contradicted this. They all greatly enjoyed the much-desired tobacco, for the provision at the station had given out some time before, and they had been obliged, willing or unwilling, to practice abstinence, and not to smoke. When they had got entirely out, they had broken up their clay pipes and chewed the pieces for the sake of the taste of the little tobacco that had been absorbed in them.

A little while after casting anchor, we visited the summer tents of the natives. We had not got very close to them before their proximity became quite obvious by the strong odor of the skins of which they were made. The front part, which is made of split, semi-transparent skins, impressed itself very strongly and disagreeably on my

olfactory nerves, and when I drew the curtain and looked around on the piles of meat, the filthy cooking-vessels, and the heaps of reindeer-skins in the background, I ran out and away as quickly as I could. If any one had told me then that I would soon be living without repugnance in just such surroundings, I should have resented the insinuation very angrily. But it was not long before the stress of circumstances and custom brought me to it, and I too found myself sharing the deer-skin bed-place of the natives and cooking with them in the same kettle, though I generally took the precaution to use my own. Even the store of meat heaped up in the sides of the hut was often only too welcome to me, as was also the hospitable lamp by which the housewife sat caring that the wick should be kept well supplied with oil, and should burn evenly without smoking. With what joy, returning from a journey wet and chilled through, did I often greet the cheerful fire which warmed the hut comfortably, and the kindly hostess who dried and cleaned my clothes; and how haltingly did I as often leave the hospitable roof to go out on my solitary journeys from coast to coast, or into uninhabited regions!

The few tents which we found on our arrival at Kikkerton were inhabited by the Eskimos of the Scottish station, while all the other natives had gone fur-hunting; for as soon as the spring fishing is over and the sound is tolerably free from ice, they go in their boats up the fiords and set up their tents at the extreme ends of them.

While the women and older men stay here to catch salmon, of which immense numbers abound in the ponds and rivers at this season, the younger and more active go for days' journeys into the interior, sometimes getting as far as a hundred miles or more from their settlements. If they kill a large number of reindeer, they only bring the best meat and the skins on their backs to the camp. Then a great feast is given. All the people of the settlement are called together. An open fire of brush blazes under the kettle of meat, and every one has his part in the meal. The skins are carefully preserved, to be made up afterward into winter clothing. A favorite summer resort of the Eskimos is the great Lake Netilling, west of Cumberland Sound, the shore of which is frequented by numerous herds of that animal; and many start for that place with sledges in May.

While I was exploring the east coast of the sound with boats in the fall, a large number of Eskimos came back from their summer journeys. Some of them used old whale-boats, which they had got from some ship. The craft were loaded to the edge with the skins obtained during the season. Men, women, and children were singing, laughing, and chattering, dogs were howling, and every once in a while one person or another would reach down into the always-full pot that stood in the middle of the boat. Only the helmsman sat earnest and majestic on his high seat, and steered his craft. If the wind was unfavorable, oars were used. Occasionally a seal would lift his head out

of the water, and, if there was no particular reason for haste, they would stop, and every one would hold his gun in readiness to cover the animal if he should come up again to take breath.

All the Eskimos have returned by the middle of October, and, as it is now getting perceptibly cold, they immediately begin to build their winter houses. Several families occupy a common tent, which is now covered with brush, and over this is spread another coat of skins. The bedroom in the back of the hut and the meat- and lamp-rooms on both sides of the door are raised about two feet, so that the cold air shall not cool the living-room too much. When the lamps are burning, the room soon becomes comfortably warm, and at least a little fire is kept up day and night. Later in the winter the people begin to build their snow-houses, the size of which varies according to the number in the family. Large blocks are cut out of the wind-hardened snow, which the Eskimos skillfully build up into a high dome. The joints are carefully closed, and the whole is smoothed on the outside. The wind and the cold air are kept out of the dwelling-room by means of smaller domes and a long entrance-way. This hut, covered with skins, makes a very nice winter home.

Since the Eskimos require much blubber in the winter for their lamps, their principal hunt is for the seal. So long as the ice does not cover the whole sound, they go to its edge to shoot the seals, which are then dragged ashore with harpoons. This kind of hunting is very dangerous, for they unavoidably have to go upon the drift-ice to secure the dead seals, and this is very liable to move when the wind suddenly changes. Thus a young man, a few seasons ago, was held for three days on a cake of ice without being able to get to the shore or having anything to eat. He evidently did not lose heart, for, while his fate was still uncertain, he made a comic song about his misfortune, which is now sung by all the Eskimos in the region.

If the sea is wholly covered with ice, guns can not be used, but the hunters have to go to the breathing-holes, which the seals keep open all the winter, in order to harpoon them when they come up. The Eskimos also travel much at this season. Sledges flit from one settlement to another. Friends and relatives visit one another, and a lively trade springs up at the whalers' stations. I, too, began to travel, and, as I lived at various times in different settlements, I had opportunities to become well acquainted with the manner of life and the character of the people. At every settlement I had a host, at whose house I was accustomed to stay when I was there. A white man, moreover, is a much-esteemed guest, for he usually brings fresh provision of tobacco and bread.

In May, when the heat has become stronger, the seals are accustomed to lie upon the ice and sun themselves. Then the Eskimo brings out his gun again: he carefully approaches his victim, who is generally warily looking around; lies down upon the ice and imitates

the movements of the seal, which is taken in by the deception. When he has at last got near enough, he brings down his game with a well-aimed shot. Times are good now, for this kind of hunting yields several seals a day. Then comes the golden season of summer, bringing plenty of birds, eggs, salmon, reindeer, seals, and walruses—summer, with its gay flowers and rushing streams, freeing the seas from their icy fetters—a season which the Eskimo loves, and the beauty of which he celebrates in his songs. Thus closes the circle of the year of this people, careless and contented under the most straitened circumstances, whose hospitality and indomitable serenity I learned during my life among them to love and prize.

When, late in the fall, storms rage over the land, and again release the sea from the icy fetters by which it is as yet only slightly bound; when the loosened floes are driven one against another, and break up with loud crackings; when the cakes of ice are piled in wild disorder against or upon one another, the Eskimo believes he hears the voice of spirits which inhabit the mischief-laden air.

The spirits of the dead—the Tupilak—knock wildly at the huts which they can not enter, and woe to the unhappy person whom they can lay hold of! He immediately sickens, and is fated to a speedy death. The wicked Krikirn pursues the dogs, which die as soon as they see it with convulsions and cramps; Kallopalling appears in the water, and drags the brave hunters down, and conceals them in the great hood of his duck-skin dress. All the countless spirits of evil—the Torgnet—are aroused, striving to bring sickness and death, bad weather, and failure in hunting. The worst visitors are Sedna, mistress of the under-world, and her father, to whom dead Innuit fall.

The old stories which mothers relate during the long winter evenings to their timidly listening children tell of Sedna. Once upon a time there lived a Jnnung, with his daughter Sedna, on the solitary shore. His wife had been dead for some time, and the two led a quiet existence. Sedna grew up to be a handsome girl, and the youth came in from all around to sue for her hand, but none of them could touch her proud heart. Finally, at the breaking up of the ice in the spring, a fulmar flew from over the sea and wooed Sedna with enticing song. "Come to me," it said; "come into the land of birds, where there is never hunger, where my tent is made of the most beautiful skins. You shall rest on soft deer-skins. My fellows, the storm-birds, shall bring you all your heart may desire; their feathers shall clothe you thickly; your lamp shall always be filled with oil, your pot with meat." Sedna could not long resist such wooing, and they went together over the vast sea. When at last they reached the country of the fulmar, after a long and hard journey, Sedna discovered that her spouse had shamefully deceived her. Her new home was not built of beautiful pelts, but was covered with wretched fish-skins, full of holes that gave free entrance to wind and snow. Instead of white

reindeer-skins, her bed was made of hard walrus-hides; and she had to live on miserable fish which the birds brought her. Too soon she discovered that she had thrown her fortune away when, in her foolish pride, she had rejected the Innuit youth. In her woe she sang:

"Aya! father, if you knew how wretched I am, you would come to me, and we would hurry away in your boat over the waters. These strange birds look unkindly upon me. The cold winds roar around my bed; they give me miserable food—oh, come and take me back home! Aya!"

When a year had passed, and the sea was again stirred with warmer winds, the father left his land to visit Sedna. His daughter greeted him joyfully, and besought him to take her back home. The father, pitying his daughter, took her in his boat while the birds were out hunting, and they quickly left the country which had brought so much sorrow to Sedna. When the fulmar came home in the evening, and found his wife not there, he was very angry. He called his fellows around him, and they all flew away in search of the fugitives. They soon discerned them, and stirred up a great storm. The sea rose in immense waves, that threatened the pair with destruction. In his mortal peril the father determined to offer Sedna up to the birds, and threw her overboard. She clung with a death-hold to the edge of the boat. The cruel father then took a knife and cut off the first joints of her fingers. Falling into the sea, they were changed into seals. Sedna, holding to the boat more tightly, the second finger-joints fell under the sharp knife, and swam around as ground-seals; when the father cut off the stumps of the fingers, they became whales.

In the mean time the storm subsided, for the storm-birds thought Sedna was drowned. The father then allowed her to come into the boat again. But she from that time cherished a deadly hatred against him, and swore bitter revenge. After they got ashore, she called up two dogs, and let them eat the feet and hands of her father while he was asleep. Upon this he cursed himself, his daughter, and the dogs which had maimed him, when the earth opened and swallowed hut, father, daughter, and dogs. They have since lived in the land of Adliwun, of which Sedna is the mistress.

The seals, ground-seals, and whales, which grew from Sedna's fingers, increased rapidly, and soon filled all the waters, affording choice food to the Innuit. But Sedna has always hated those people, whom she despised when on the earth, because they hunt and kill the creatures which have arisen from her flesh and blood. Her father, who has to get along by creeping, appears to the dying; and the wizards often see his crippled hand seizing and taking away the dead. The dead have to stay a year in Sedna's dismal abode. The two great dogs lie on the threshold, and only move aside to let the dead come in. It is dark and cold inside. No bed of reindeer-skins invites to rest; but the new-comer has to lie on hard walrus-hides.

Only those who have been good and brave on the earth escape Sedna, and lead happy lives in the upper-land of Kudliwun. This land is full of reindeer ; it is never cold there, and snow and ice never visit it. Those, also, who have died a violent death may go into the fields of the blessed. But whoever has been with Sedna must always stay in the land of Adliwun, and hunt whales and walruses. With all the other evil spirits, Sedna now lingers in the fall among the Innuit. But, while the others fill the air and the water, she rises from under the ground.

It is then a busy season for the wizards. In every hut we may hear singing and praying, and conjuring of the spirits is going on in every house. The lamps burn low. The wizard sits in a mystic gloom in the back part of the hut. He has thrown off his outer coat and drawn the hood of his inner garment over his head. Muttering undistinguishable words, he throws his arms feverishly around his body. He utters sounds which it is hard to ascribe to a human voice. At last the guardian spirit responds to the invocation. The *Angeko* lies in a trance, and when he comes to himself he promises, in incoherent phrases, the help of the good spirit against the Tupilak, and informs the credulous, affrighted Innuit how they can escape the dreaded evil.

The hardest task, that of driving away Sedna, is reserved for the most powerful wizards. A rope is coiled on the floor of a large hut, in such a manner as to leave a small opening at the top, which represents the breathing-hole of a seal. Two wizards stand by the side of it, one of them holding the seal-spear in his hand as if he were watching at the seal-hole in the winter, the other holding the harpoon-rope. Another Angeko sits in the back of the hut, whose office it is to lure Sedna up with magic song. At last Sedna comes up through the hard earth, and the Angeko hears her heavy breathing ; now she emerges from the ground, and meets the wizards waiting at the hole. She is harpooned, and sinks away in angry haste, drawing after her the harpoon, to which the two men hold with all their strength. Only by a desperate effort does she tear herself away from it and return to her dwelling in Adliwun. Nothing is left with the two men but the blood-sprinkled harpoon, which they proudly show to the Innuit.

Sedna and the other evil spirits are at last driven away, and a great festival for young and old is celebrated on the next day in honor of the event. But they must still be careful, for the wounded Sedna is greatly enraged, and will seize any one whom she can find out of his hut. So, on this day, they all wear protecting amulets on the tops of their hoods.

The men assemble early in the morning in the middle of the settlements. As soon as they have all got together, they run screaming and jumping around the houses, following the course of the sun. A few, dressed in women's jackets, run in the opposite direction. They are those who were born in abnormal positions. The circuit made, they

visit every hut, where the woman of the house must be waiting for them. When she hears the noise of the band, she comes out and throws a dish of little gifts of meat, ivory trinkets, and articles of seal-skin into the yelling crowd, of which each one helps himself to what he can get. No hut is spared in this round.

The gang next divides itself into two parties, the Ptarmigans—those who were born in the winter—and the Ducks, or the children of summer. A large rope of seal-skin is stretched out; each party takes one end of it, and tries with all its might to drag the opposite party over to its side. But they hold fast to the rope, and try as hard to make ground for themselves. If the Ptarmigans give way, then summer has won the game, and fine weather may be expected to prevail through the winter.

The contest of the seasons having been decided, the women bring out a large kettle of water, and each person gets his drinking-cup. The company stand close around the kettle, while the oldest man steps out first from among them. He dips a cup of water from the vessel, sprinkles a few drops on the ground, turns his face toward the home of his youth, and says, "My name is Naktukerling, and I was born in Kajossuit." He is followed by an aged woman, who announces her name and home; and then all the others do the same, down to the youngest children, who are represented by their mothers. As the words of the old are listened to respectfully, those of distinguished hunters are received with demonstrative applause, and those of the others with different kinds of attention, down to familiar rallying.

Now arises a cry as of surprise, and all eyes are turned toward a hut out of which stalk two gigantic figures. They wear heavy boots, their legs are swelled out to a wonderful thickness by several pairs of breeches, their shoulders are covered by a woman's over-jacket, and their faces by tattooed masks of seal-skin. In their right hands they carry the seal-spear, on their backs an inflated buoy of seal-skin, and in their left hands the *tcssirkun*, the tool with which the skins are prepared. Silently, and with long strides, the *Kailertetang* approach the assembly, who, screaming, press back from before them. The pair solemnly lead the men to a suitable spot, and set them in a row, against which they set the women in an opposite row. They match the men and women in pairs, and these pairs run, pursued by the Kailertetang to the hut of the woman, when they are for the following day man and wife. Having performed this duty, the Kailertetang speed down to the shore, and invoke the good north wind, which brings fair weather, while they warn off the unfavorable south wind.

As soon as the incantation is over, all the men attack the Kailertetang with a great noise. They act as if they had weapons in their hands, and would kill both the spirits. One pretends to probe them with a spear, another to stab them with a knife; one to cut off their arms and legs, another to beat them unmercifully on the head. The

buoy which they carry on their backs is ripped open and collapses, and soon they both lie as if dead beside their broken weapons. The Eskimos leave them to get their drinking-cups, and the Kailertetang awake to new life. Each one fills his seal-skin with water, passes a cup to them, and inquires about the future, about the fortunes of the hunt, and the events of life. The Kailertetang answer in murmurs, which the questioner must interpret for himself.

Thus ends this day, in which laughing and singing, joy and gladness prevail. On the morrow the Eskimo goes back to his daily life, but the autumn festival is the subject of talk in the hut and on the hunt for weeks afterward.

THE RELIGIOUS VALUE OF THE UNKNOWABLE.*

By the Count GOBLET D'ALVIELLA,
PROFESSOR OF THE HISTORY OF RELIGIONS IN THE UNIVERSITY OF BRUSSELS.

WE have not to take part here for or against the philosophy of Evolution. The only points we wish to examine in the controversy are, first, if the historical development of the religious sentiment can be summed up into a gradual reduction of the divine attributes, into a simplification, or, to borrow Mr. Spencer's barbarous term, a deanthropomorphization of the divinity; next, if the theory of the Unknowable has all the elements necessary to beget a religion; and, lastly, if the religious sentiment is tending to divest itself of every moral element, or whether it is destined, as the Comtists maintain, to confound itself with altruism or devotion to humanity.

Mr. Harrison sharply criticises the theory that ascribes the origin of religion to *doubles* appearing in dreams. We are not fanatics in regard to this hypothesis, but would prefer to admit, with M. A. Réville, that religion began with the worship of natural objects or cosmic phenomena personified, animated, *anthropomorphized* by the imagination of the primitive man. But these reserves involve no impeachment of Mr. Spencer's general reasoning, so far as concerns either the spiritual nature of the first notion that man formed of the divine, or the work of simplification and purification which that notion has constantly undergone in the course of ages. The thesis of Mr. Harrison, on the contrary—that man began with the adoration of natural objects frankly regarded as such—appears to us absolutely contrary to reason and observation. He cites, for example, the ancient religion of China, which was based entirely on veneration of the earth, the sky, and ancestors, considered objectively and not as the residence of immaterial

* From "The Nature and Reality of Religion," being the last part of the author's review of the controversy between Mr. Spencer and Mr. Harrison, in which he presents his own conclusions.

beings. This is to play at hazard, for, without insisting on what ancestors "considered objectively" may be, it has been found precisely that the religion of the ancient Chinese Empire is the most perfect type of organized animism, and that it regarded even the material objects out of which it made its gods as the inseparable manifestation, the envelope, or even the body of invisible spirits.*

How shall we explain it that after the works of Tylor, Spencer, Max Müller, Réville, and Tiele, a thinker as intelligent and well-informed as Mr. Harrison can still pause at a thesis long ago passed by by science? It is, we believe, a remarkable instance of the influence which Auguste Comte still exerts over his orthodox disciples, and which can only be compared with that of Aristotle over the scholastics of the middle ages. We know that Comte borrowed from President De Brosses the hypothesis of primitive fetichism, and that he introduced it in the series of three states (fetichism, polytheism, and monotheism), through which religion in his view had invariably to pass.

We think, then, that Mr. Spencer is right in representing the evolution of the idea of God as tending to render the object of worship less and less sensible to man, more and more incapable of falling under our senses. But this process of abstraction must stop somewhere, else even the existence of God will at length become its victim, and that would evidently go beyond the Spencerian doctrine. The whole problem consists, then, in knowing where this stopping-place is to be found; and, according as we start from spiritual theism, from pantheism or from agnosticism, we shall be able to reach a different solution without really departing from the line of religious development.

Mr. Spencer, on his side, estimates that the end will be reached when the idea of God has been divested of all limitation and of every condition. There will then remain for us the one absolute certainty, that man "is ever in the presence of an Infinite and Eternal Energy, from which all things proceed."

Is there nothing here but a pure negation, as Mr. Harrison asserts? The terms of the formula themselves prove that the question is of what may be supposed to be the most positive thing in the world—the stuff of which the Universe is made. Mr. Spencer speaks repeatedly of the Unknowable as the power that manifests itself at the same time in the Universe and in the Consciousness, as the Supreme Reality which is concealed behind the changing course of phenomena. He attributes to it, as Mr. Harrison recognizes, unity, homogeneity, immanence, unlimited persistence in time and space. He assigns it, for modes of action, the laws of the Universe; he sets it face to face with phenomena, both internal and external, in the relation of substance to manifestation, if not of cause to effect. Still more, the Comtist critic

* See, notably, Tiele, "Manuel de l'Histoire des Religions," translated by M. Maurice Vernes, Book II; and in the "Revue de l'Histoire des Religions," the "Religion de l'Ancien Empire Chinois," by M. Julius Happel (Vol. IV, No. 6).

himself admits that we may accept with full confidence all that the evolutionist philosophy affirms and contests with reference to the permanent indications of an ultimate energy. Now, is not this concession of Mr. Harrison's the complete refutation of his thesis relative to the negative nature of the Unknowable?

He adds, indeed, that an existence of which we can know nothing remains, in the religious point of view, as if it did not exist. To this objection it may be replied that he consents himself to admit mystery as an element of the religious sentiment. We will only add to this, with Mr. Spencer, that it is an essential element of it, and in this respect the Unknowable is susceptible of satisfying the most difficult imaginations, for it is the mystery of mysteries, and something that we may be sure will never be cleared up in this world, whatever may be the progress of science. Mr. Harrison commits an error—especially strange with a positivist—when he reproaches evolutionism for using the term Unknowable instead of Unknown. The Unknown includes a knowable part, the sum of the phenomena and laws which still escape our perception, but which we may be able to know and doubtless will know more and more. The Unknowable, on the other hand, represents what will always escape our knowledge by virtue of our intellectual organization itself—the first cause, the Noumenon, the essence of things—unless Mr. Harrison, urging the doctrine of positivism to an extreme, prohibits us from mentioning all that transcends phenomena and their relations, even in order to declare it Unknowable! As M. Littré admits: "Immensity, material as well as intellectual, appears under its double character of reality and inaccessibility. It is an ocean that beats against our shore, and for which we have neither bark nor sail, but the clear vision of which is as salutary as formidable!"

A second element, which every one agrees in declaring characteristic of religion, is that feeling, of a complex nature, which is interpreted, according to circumstances, into wonder or fear, enthusiasm or stupor, before the object of religious contemplation. Is not this one of the impressions most easily engendered by the discovery of that mysterious energy that rises, at the end of all our investigations, in all the avenues of knowledge, as if by the conception of that substantial stratum which remains when all else changes and passes away—primordial foundation of Nature and consciousness, without which, if we could only suppose it absent for a second, the whole Universe would resolve itself into chaos or into nothing?

Schleiermacher referred the essence of religion to a feeling of dependence. Does not Evolution teach that the force of which we are conscious whenever we produce a change by our own effort is correlative to the power that transcends consciousness, and can we imagine a closer dependence than this relation of the individual with the ultimate Energy of which it is, like all of Nature, a transient production?

It is of a power conceived in this manner that we may well say, *In illo vivimus, movemur, et sumus* (in it we live, and move, and are).

The conditions indispensable to becoming the object of a religion are thus found in the Unknowable, as well as in the Eternal, the Absolute, the Self-Existent, the Most High, the Only Pure, or whatever other qualifications men may have made the equivalent of the divine. The last word of Evolution agrees with the definitions of the most refined theologists, which, transcending vulgar symbolism, have constantly recognized God in the double character of reality and incomprehensibility. We may add that, before becoming the scientific faith of Spencer, Huxley, and even of Haeckel, this religious conception has sufficed for men of the highest mind and the most pious imagination, such as Giordano Bruno, Spinoza, Kant, Goethe, Shelley, Wordsworth, Carlyle, Emerson, and even M. Rénan. It can lead not to religion only, but even to mysticism, however little, like some Neoplatonists and certain Hindoo philosophers, one may become absorbed in the conception of the supreme unity.* Under this relation, the danger is not that it will remain without influence, but that it will communicate to its adepts a kind of vertigo more formidable than the fascination of the abyss, either by the contrast of its incommensurable grandeur with the insignificance of our being, or by the opposition of its immutable Unity with the unlimited Variety and perpetual expansion of the material Universe. These sentiments, as Mr. Spencer remarks, can only increase in frequency as well as in intensity as the human mind becomes more capable in seizing the comprehensiveness of things and their complex relations.

Certainly, it is no longer possible to attribute to that Supreme Reality goodness, consciousness, and personality, *as we conceive them.* But do our conceptions exhaust the modes of the infinite? Mr. Harrison will see only the negative side of the Unknowable. Whether you employ, he tells us, the term existence or energy, you never have anything but a scientific generalization, a dumb, blind, insensible entity, without common attributes, and consequently without possible

* We cite, for example, the following passage from an address made by the great mystic of the Bramo Somaj, Keshub Chunder Sen, at a time when no one accused him of having transgressed the most strict rationalism: "(For the true Yogui) forms become informal, the informal takes form. Mind discovers itself in matter, matter transforms itself into mind. In the glorious sun is revealed the glory of glories. In the serene moon mind imbibes of all serenities. In the reverberation of the thunder is the Voice of the Lord which makes itself heard afar. All things are full of Him. Open your eyes, behold he is without; shut them, he is found within. Then your asceticism (*yoga*), O disciple, will be complete; aspire constantly to this plenitude." There is not a word in these exalted conceptions in contradiction with the religious conceptions of Mr. Spencer. Haeckel himself has said in his "Morphology": "The philosophy which sees the mind and force of God acting in all the phenomena of Nature is alone worthy of the grandeur of the Being who embraces all. . . . In him we live, and act, and are. The philosophy of nature becomes theology." All depends on the mental angle under which the disciple of Spencer contemplates Nature, or the manifestations of the Unknowable.

sympathy with man. Mr. Spencer meets the objection in advance in his "First Principles." "Those who espouse this alternative position," he says, "make the erroneous assumption that the choice is between personality and something lower than personality; whereas the choice is rather between personality and something higher. Is it not just possible there is a mode of being as much transcending Intelligence and Will as these transcend mechanical motion? It is true that we are totally unable to conceive any such higher mode of being. But this is not a reason for questioning its existence; it is rather the reverse. Have we not seen how utterly incompetent our minds are to form even an approach to a conception of that which underlies all phenomena? Is it not proved that this incompetency is the incompetency of the Conditioned to grasp the Unconditioned? Does it not follow that the Ultimate Cause can not in any respect be conceived by us because it is in every respect greater than can be conceived?"

Energy is a word that has a bad sound to many ears. We apprehend in it the idea of brute, of material force. Here, again, Mr. Spencer is able to tell us that we let ourselves be carried away by the analogy of muscular effort. But all the languages of civilized peoples permit us to rise above this literal acceptation, and to interpret the term in a larger sense, as implying mental and moral activities. If the Universe, with its laws and harmonies, if man with his capacities and aspirations, proceed from the same Energy, it must be that that Energy contains in puissance whatever in our eyes goes to constitute the grandeur of Nature and the glory of the human mind. Further, as it should likewise include the germ of all its future, or even possible developments, it must necessarily represent a cause superior to all its known effects—that is, to the finest and highest manifestations of that which we regard as the rational order of things.

Mr. Harrison finally declares that the Unknowable can never have temples, rites, or ministers. We will not inquire here to what point these are indispensable elements of religion. The ascetic school of India, a fruit of the reaction against the excessive ritualism of the Brahmans, has always dispensed with external worship. We can easily conceive the religions of Mohammed and Confucius as without mosques or pagodas. Buddhism probably had convents long before it built temples. At Rome itself, seventeen centuries ago, there flourished a sect already numerous, whose partisans and adversaries agreed in saying that it had neither temples nor altars nor images.* So it was regarded as atheistical. It must be acknowledged that the sect has acquitted itself well since then. In any case, the affirmation of the Comtist writer is already contradicted by the facts. Not only have we Protestant theologians, more or less orthodox, who are endeavoring to reconcile the doctrine of evolution with faith in the Christian revelation, but we can point to liberal and even Unitarian congregations

* Minutius Felix, Octav, pp. 10, 32.

in America and England, whose whole theology consists in Mr. Spencer's religious conception, and who do not hesitate to avow the fact. If Mr. Harrison will take the pains to visit them, he will see that, even after all the old theological formulas have been given up, the Unknowable can serve as the foundation of a worship, without being reduced to the formula and symbol of x".

But these disciples of Spencer, by developing the religious consequences of his doctrine, have made up for his silence on perhaps the only point in which he exposes his flank to the attacks of Comtism. Feeling that the flaw in the armor is revealed here, Mr. Harrison keeps on reiterating the charge, and reproaching his adversary with having forgotten that religion necessarily includes a moral discipline. We believe it is inexact to assume that morals is an original element of religion, but it incontestably, by the progress of ideas, has become an essential one. In reducing religion to a sort of mystic contemplation, Mr. Spencer has left out those moral sentiments and practical applications which, according to the just remark of Mr. Harrison, are the real sphere of religious activity. Evolution confides to science the task of formulating the laws of ethics, or, in more general terms, the principles of the true, the good, and the beautiful. But does Science, which addresses itself exclusively to the reason, possess a sufficient sanction to guarantee, under all circumstances, the triumph of those laws over the appetites or the passions of the individual, when once the commandment of a divine revelator or the categorical imperative of Kantian morals has been replaced by the simple suggestions of plain interest? It is, we believe, in sentiment, as Comte and his disciples declare, that must be sought the mainsprings of duty, of devotion, of the spirit of sacrifice, and of all the virtues which, perhaps, yet more than mental progress, make up the grandeur of the individual and the strength of societies.

What is this sentiment, which, to attain its end completely, must represent our deepest and most intense aspirations? Worship of Humanity, replies Mr. Harrison, following Comte. But humanity can not isolate itself from Nature, and Nature itself is simply the phenomenal manifestation of the Supreme Energy. Mr. Spencer has already said, in his first studies of sociology, that nothing like humanity can remove, save temporarily, the idea of a power of which humanity is the feeble and fugitive product, a power which, under ever-changing manifestations, existed long before humanity, and which will continue to manifest itself under other forms when humanity shall be no more.

It remains to examine whether the contemplation of this power can provoke in us sentiments that will practically affect our conduct. The response can only be affirmative, provided we consent, with Mr. Spencer, to regard the laws which reason discovers in the moral as well as in the physical world as modes of the Unknowable. Comte has defined religion as the state of spiritual unity resulting from the conver-

gence of all our thoughts and all our acts toward the service of humanity. How much stronger and more efficacious would this state of spiritual unity become if, instead of resting exclusively on the necessary relations of men, it based itself on the sum of our relations with the Universe, and if, while retaining as its object the reign of justice or happiness in human society, it enveloped that object in the broader end of the conformity of our conduct with the action of the power "other than ourselves, which labors to put order into the world," or, as Matthew Arnold defines it in his felicitous and celebrated formula, "the Power not ourselves, that makes for righteousness"!

But is not this to attribute to the Unknowable an object, a design, a will—attributes absolutely incompatible with the unconditioned and the infinite? Is it not, in short, to return to the doctrine of final causes which has been proscribed by Evolution?

We may answer that, if modern science has cast discredit on the old system of final causes, it has not, it appears, prohibited us from assigning a certain end to the evolution of the Universe taken as a whole; that the tendency toward this end, aside from knowing whether it is conscious or not, intelligent or not, is easily substantiated by the numberless indications of a gradual progress in the development of nature as well as of humanity; and that this tendency toward a determined end contradicts the system of evolution only in so far as it may be copied after the manifestations of our volitional activity. If a person holds that the notions of object, end, tendency, and predetermination are derived from our subjective experiences, we should observe—as Mr. Spencer has done of our notion of force, deduced from the muscular effort—that we are constrained to think of external energy in terms borrowed from our consciousness of internal energy, and that there is nothing to prevent our seeing equally in the notions thus formed the simple symbol of the reality. The essential point is not to forget that here also the Unknowable should be superior and not inferior to our broadest conception of the human faculties.

We have, however, no need at this time to go beyond Mr. Spencer's written thought. He affirms that the laws of Nature are the modes of action of the Unknowable, and that the most important of them, the law of evolution, tends, in the existing Universe, to equilibrium, harmony, and co-ordination, which is interpreted in the moral world by a more complete submission to the injunctions of duty, by the introduction of more justice into the relations of men; in short, by the gradual realization of the conditions necessary to the constant progress of the individual and of society. The more, then, man is conscious of his relations with the Unknowable, and the more he comprehends the solidarity that binds all parts of the Universe, chiefly the members of humanity, the more he will grasp the importance of his modest part in the great drama of Evolution, and the more he will

feel inclined to follow the elevated aspirations of his nature, regarded as the expressions of the Eternal Energy, which, if the philosophy of Mr. Spencer is not a vain illusion, is leading us toward a better future.

Thus the religion of the Unknowable assimilates to itself an ultimate factor which is found in all religions ; the desire of uniting one's self with the object of worship, or, at least, of conforming to the rules that proceed from it. Mr. Spencer seems himself to have comprehended the necessity of this extension, if we may judge from a letter which he addressed last year to one of his most earnest disciples in the United States, the Rev. J. M. Savage, a Unitarian minister, in which he felicitated him on having clearly brought out the religious and ethical sides of evolutionary doctrines.

On the other hand, the resources which the religious spirit discovers in the doctrine of the Unknowable have struck even some of Mr. Harrison's co-religionists, who, less bound, perhaps, to the letter of Positivist tradition, have recognized the necessity of giving a broader and more solid support to the worship of Humanity. As Mr. William Frey, an American Comtist, wrote to the Boston "Index" in 1882, the strong feeling which the Comtists experience toward humanity can only become deeper and more intense if they regard it as a mediator between men and the Unknowable, because there will come into play the strongest cord of the religious sentiment—the aspiration of man toward the Infinite.

We should not be surprised at the influence, amounting to a kind of fascination, which the philosophy of Mr. Spencer exercises over an increasing portion of the Anglo-Saxon public. Whether true or false, complete or incomplete, it unquestionably represents the vastest and grandest synthesis that human genius has produced for a long time. After having embraced in succession all the phases of cosmical evolution, all the degrees of organic, sensible, intellectual, and social development, we could foresee that the eminent thinker would enter the domain of religious ideas to inquire into the application of his general law there. We have seen by what conclusions, at once sympathetic and original, his views, in this regard, trench upon nearly all the systems that have issued from the contemporaneous scientific movement.

In 1860 Mr. Laugel called him the last of the English metaphysicians. Mr. Spencer would no more accept this designation now than then. It is nevertheless true that his doctrine of the Unknowable, as Mr. Harrison asserts, is, before everything, of theology, and that in his hands the evolution of Religion becomes the religion of Evolution. The future alone can tell what lot is reserved for this conception, which is doubtlessly not new in itself, but which, for the first time, perhaps, is presented to us as the logical and indispensable complement of a system exclusively based on Positivist methods.

LIQUOR LEGISLATION.

By GORHAM D. WILLIAMS.

DURING the past eight years as a magistrate with criminal jurisdiction in a town of about four thousand inhabitants, in Western Massachusetts, I have disposed of about five hundred cases of drunkenness, and numerous cases of common drunkards, brought before me on complaint. The proceedings have not been mere routine, as, of necessity, they usually are in such cases in the large cities, where the judge sits back in his chair until the list of the morning's "drunks" has been finished by the clerk, who calls name after name, with the formula, "John Smith, you are complained of for being drunk yesterday. What do you say to this complaint, are you guilty or not guilty? You are sentenced to pay a fine of one dollar and costs, and to stand committed to the House of Industry for ten days, or till the same is paid"; and who begins to write the memorandum of the sentence as soon as he calls the name, and scarcely pauses for the plea of guilty. In the cases coming before me I usually have from the officer making the arrest some description of the circumstances under which it has been made, while in the cases of common drunkards I usually know something of the history of the defendant. In cases of simple drunkenness, the law being the same, I usually end with a sentence like that given above, though occasionally I adjourn a case for sentence, and give the defendant a chance to raise or earn the money, and pay the fine on a subsequent day. The case of a common drunkard is not so easy to dispose of, for, in the first place, he is liable to a severer punishment, then he is usually a resident of the town, I know all about him and his family, if he has one, and there is a sort of an acquaintance between us on account of his having been before me on numerous occasions for simple drunkenness. Moreover, he has just been on a spree, and is in a condition of reaction, confident that he will never desire to drink intoxicating liquor again, and full of good resolutions. All this leads to an appeal for a chance to show that he is a reformed man, to promises that he will never give occasion to be arrested again, and to offers to take the pledge, and usually ends with the sentence being postponed for a week or two—then for a month, and then indefinitely, after which he is arrested a number of times for drunkenness, and, the patience of officers and magistrate becoming worn out, the complaint for being a common drunkard is revived, he is sentenced and appeals, counsel is employed, and his case drags along in the superior court.

The law as to drunkenness and common drunkards, as it now stands, can not be administered with any satisfaction. The imposition of a fine in such cases is a punishment whose burden, if the fine is paid, is

borne by the family of the drunkard, whose condition, already wretched enough on account of the vice to which he is addicted, is thus made still more deplorable. Imprisonment for a first offense is not permitted, and in any case seems a punishment disproportioned to an offense in the commission of which the defendant has done himself more harm than he has the public; and this is especially true when the arrest has been made, as frequently happens in the winter, out of pure compassion, to save the defendant from injurious exposure to the cold. Besides, short sentence to imprisonment can be no satisfactory offset to the expense already incurred in the arrest, for, as a prisoner on short sentence, the convict becomes the occasion of an additional item of expenditure. To discharge him without sentence is the only other course open, and this it is useless to discuss if it is to be admitted that an arrest should be made at all.

The experience gained from the cases mentioned, although they have not been exceedingly numerous, has yet been sufficient to teach me some facts, and to occasion a good deal of thought on the matter of temperance legislation. I have noticed that the number of arrests for drunkenness has not varied with the number of places open for the sale of intoxicants. In fact, in one year, when no licenses for their sale were granted in our town, the arrests were unusually numerous, and this was due to the fact that there were a large number of imported laborers employed in certain railroad-work in the neighborhood, and that from among them the "drunks" were furnished. From this it would seem that the habits of the community have more to do with the consumption of intoxicants than the number of places of sale. The nationality of the persons arrested looks in the same direction The simple "drunks" have been for the most part Irish; the common drunkards, American, who have been almost exclusively permanent residents, perfectly well known to the overseers of the poor, the peace officers, and the magistrates. I can not recall that a German has ever been before me for either offense, and this although there is a large German population in the village where I reside. From all the foregoing I come to the conclusion that the present license law in Massachusetts does not, and that the prohibitory law when in existence did not, affect the drinking habits of more than a very small portion of the community. The question is, What legislation is necessary or desirable under these circumstances?

The unusual characteristics of the presidential election of 1884 have thrown into peculiar prominence a movement to make prohibition of the traffic in intoxicating liquors a national issue. The object of this movement is to get incorporated into the fundamental law of the Federal Union, by way of constitutional amendment, a provision for such prohibition or requiring such prohibition by the States. To one who has made even a superficial study of the Constitution of the United States this must seem a wide departure from the spirit in which that instru-

ment was framed. It proceeds upon the claim that any use of intoxicating liquors as a beverage is injurious to the user, a claim not yet proved, and certainly not yet by any means admitted, and that whatever is injurious to an individual, if it in any way affects the public injuriously, may be prevented, not by direct punishment of the offender, but indirectly by a sweeping prohibition forbidding all persons to furnish the means of committing the offense. If such law-making can be defended at all, it can be only as the making of police regulations, for which the frame of government of a federation of States seems a very curious place. Amendments or provisions of the Constitutions of the several States are equally objectionable on considerations of sound legislation. The great mistake made by temperance agitators who favor prohibition is that they expect too much from the mere passage of laws. They know that in our highly civilized, orderly, and law-abiding communities there are laws for the punishment of all the grave offenses, such as murder, arson, burglary, and the like, and against almost innumerable misdemeanors and petty offenses; they see that offenses against such laws are not of frequent occurrence, and by hasty generalization, and usually without experience in the workings of the law, they draw the conclusion that the passage of a law making a certain act an offense and forbidding it has a potent effect in preventing it. In spite, however, of all the experiments that have been tried in legislating on the sale of intoxicating liquors, and varied and numerous statutes on the subject, the evil aimed at still exists. Hasty reasoning from this state of facts leads to the conclusion that it is not the law that is in fault, but the method of its enactment. Our prohibitionist friends know that there are no departures to a noticeable extent from the provisions of the Constitution of the United States and of the several States, and conclude that if they can get the enactment they desire into the Constitution it will have an effect that it can not have while only existing in the form of a statute. The real reason that there are violations of statutes and not of the provisions of Constitutions is that statutes and Constitutions deal with, and are intended to deal with, different kinds of law. The Constitution in general terms provides the frame of government for the State, distributes the legislative, judicial, and executive functions, and sets forth the powers of the Legislature, the courts, the Governor, and his associates; while statutes are enacted to fill in the details not covered by the Constitution, to erect and prescribe the powers of municipal, religious, charitable and other corporations, to regulate the relations of individuals to one another, the making of contracts, the settlement of estates, and the like, and to provide for the punishment of offenses against the community. A statute has the same force and effect while it exists that a provision of the Constitution has. It is easy to be understood that a constitutional provision for the punishment of murder would not be in the least more likely to prevent the commission of

that crime than a statute to the same effect. How, then, can it be expected that the recent adoption of a constitutional amendment in Maine is going to have any effect in the prevention of the sale of intoxicating liquors? Such sale has been forbidden in that State for more than thirty years. Prohibition has been the law of the State for all that time just as much as it will be now, and, if it has failed in the past to produce the result intended, so will it in the future.

I have said that offenses agains tthe law are not of frequent occurrence, and of course that is to say in comparison with the ordinary events of life. Not one man in a hundred, probably, has even violated the provisions of the law as to the sale of intoxicating liquor. But violations of the law are more frequent in some communities than in others. The same law against murder prevails throughout the city of New York, for instance, but in certain parts of that city murder is of common occurrence when compared with other parts. The law forbids murder in all the Southern States, yet certain kinds of murder, by comparison with the Northern States, are of frequent occurrence there and go unpunished; and this is true to such an extent as to be an occasion of reproach to the condition of public sentiment there. Dueling was forbidden and punishable for many years before public sentiment was such as to permit the enforcement of the law. Now the statutes against dueling have become of little consequence, because public opinion about dueling is a sufficient law. Laws do not make people virtuous, honest, or temperate, by their mere passage. When laws punishing crime, fraud, and intemperance are enforced, they do have an influence in their prevention. But for the enforcement of the law we need not only persons ready to set prosecutions on foot and officers ready to serve warrants of arrest, but we need also courts and juries ready to convict on sufficient evidence, and witnesses willing to testify. For all these we must have an overwhelming public sentiment in favor of the law, and this is true not only of large communities like States and counties, but of small communities like villages and hamlets. Neither murder nor any other crime can be punished if those who have knowledge of the facts connected with it will not tell what they know. This is especially true of any class of crimes in which all the participants are held equally guilty; in illustration of which is the notorious difficulty of obtaining convictions for offenses against the laws as to the relations of the sexes. It is also true of offenses against the laws now under consideration, not because both parties to a sale of intoxicating liquor are held equally guilty, but because both are participants in the act which constitutes the offense, and all manly feeling, of which even drunkards have a little, revolts at testifying in such a case.

But even with public sentiment in favor of the enforcement of prohibitory laws, they have no such influence as persuasion and education. Another mistake made by temperance agitators, and one which follows

from that previously mentioned, is that they do not pursue methods calculated to bring them in contact with the persons whom they seek to benefit. If there were no liquor-buyers, there could be no liquor-sellers. So long as there are persons disposed to be liquor-buyers, there will be liquor-sellers, in spite of all the statutes and constitutional provisions that ever have been or ever can be enacted. The liquor crusade (I intend to use the word in no offensive sense) is now directed toward the overthrow of the liquor-seller, and not to the rescue of the liquor-buyer. I could greatly regard and admire the temperance missionary who should seek out the drunkard at his home or in the grog-shop, and endeavor to persuade him of the evil of his ways, of his power to reform, and of his capacity to become a respectable, respected, and useful member of society, and who makes the attempt to find such objects of interest for him as will make his home or some lounging-place as attractive to him as the grog-shop. Such missionaries are scarce, however. The usual temperance work consists in occasionally getting up meetings which respectable people, not drunkards, are solicited to attend, and at which some one holds forth on the evils of intemperance (which all are ready to admit), and dwells on the necessity for further legislation or a constitutional amendment. Not a suggestion is made that it is desirable to organize committees to solicit funds to pay for the time and services of such a missionary as aforesaid, or committees to aid him in such work. If by any chance the meeting is not devoted to a consideration of the law, and an effort has been made, or is made, to get hold of the drunkards and reform them, they are more than as likely as not to be put forward at once on their profession of reform, to tell how drunk they used to get, and to abuse persons who do not join the movement, do not believe in prohibition, and have never been drunk. Temperance work comes, too, in waves like our "cold snaps," and, after a season of intense excitement, dies away, leaving to be sure a residuum of good, but also furnishing a majority of backsliders among the reformed, to the regret of the judicious and the delight of the scoffers. What is needed is not more but different law, and sustained and unobtrusive, not spasmodic and demonstrative effort for the reform and rehabilitation of drunkards. When the history of temperance reform for the last fifty years is considered, the progress made seems astounding; but it must be remembered that the greater advance by far was made before and not since the enactment of prohibitory laws, and by persuasion, not by force.

Before going further I wish to say that I yield to no one in my appreciation of the fact that crime, wretchedness, poverty, and squalor, inevitably follow the excessive use of intoxicating drink, and that any use of intoxicants is dangerous on account of the liability that it may become excessive. I am also fully of the opinion that any law can be justified that will prevent such use of them, and, if I had the power, I would destroy every drop of alcoholic drink on the face of the earth.

But I am not prepared to admit that all the intoxicating liquor used as a beverage, or even the greater part, becomes by such use injurious to the public, so as to give it a right to interfere by prohibiting its sale, so long as any other method can be found to relieve the public from the burdens which we undertake under our system of caring for our fellows when they are unable to take care of themselves.

I am not aware that any one has ever claimed for the public a right to prohibit an individual from doing anything that does not interfere with the rights of others. If the public has no such right, it is hard to see how drunkenness becomes punishable by law unless the drunken person offensively exhibits his drunkenness. I am not aware that any one has ever claimed that the act of drinking a glass of wine or of lager-beer is morally wrong, nor that any one has ever proposed to forbid it by law. If, as is said, the use of alcoholic tonics to a certain extent is beneficial to certain persons, then there is certainly not only nothing wrong in such use, but the contrary is true. And again, if there is nothing in the use of alcoholic drinks which the public has a right to forbid, it is hard to see how it acquires a right to interfere with their sale on moral grounds alone. In a recent article in the "North American Review" Neal Dow quotes with approval certain things said by a friend of his in a conversation had with James Stuart Mill, in which his friend admits that the public have no right to interfere with what a man may eat or drink, and then claims that it has a right to do indirectly what it has no right to do directly, and gives illustrations of restrictions similar to those imposed on the traffic in intoxicating liquor. These illustrations are taken up by Dio Lewis in the latter portion of the same article and disposed of, by showing that the other restrictions depend for their justification upon grounds not set up in the case of the liquor-traffic.

Are we, then, to have an unrestricted sale, and is there no middle ground between that and prohibition, save license? Must we admit on grounds of morality that if we can not prohibit we must keep our skirts clean by refusing to regulate? The views put forward in the remainder of this article are advanced with diffidence because they are believed to be both original and new, and are a wide departure from any method which has been publicly proposed for the mitigation or removal of the evils of intemperance. The principle of high license, and, in a different relationship, that involved in the civil-damage laws, come nearer to them than anything heretofore suggested.

The quarrel that the public have with the liquor-seller is not that he furnishes the liquor-buyer with the means of injuring himself or the community. If it were, the public would have the same quarrel with the hardware-dealer who sells an axe to one who may cut himself or commit a murder with it, and with the grocer who sells matches to one who may use them to set fire to a public building. Its quarrel with the liquor-seller is that he furnishes to the liquor-buyer the means

of injuring himself and the public when he knows that it will be so used, and when he has reason to believe that it will be so used, not caring whether it is or not, and, further than this, that he does it for his own selfish gain. In short, the liquor-dealer sells his deleterious liquids for the purpose of profit with a full knowledge of their injurious tendency, and in utter carelessness as to the injury they may do. We find a recognition of the truth of this position in the provisions of the civil-damage laws, and in the restrictions placed upon licensees as to sales to minors and persons known to be drunkards.

Let us pursue this further by means of a couple of supposed instances, such as occur every day. John Smith has been, during the week, a capable and industrious workman, earning full wages every day. Saturday night he gets his pay and goes to the stores, where he falls in with boon companions and spends his week's wages at the grog-shop, standing treat and drinking himself until his money is gone. Late at night he is put out into the street drunk, the liquor-seller having got his money and being ready to close the shop. Result the first: The liquor-seller has received, say, twelve dollars, of which at least three quarters, or nine dollars, is profit. Result the second : Smith is arrested and put into the lock-up for the remainder of the night ; in the morning he is brought before a magistrate and fined one dollar and costs amounting to at least five dollars, and usually more, for want of which he goes to jail for ten days. Result the third : Smith's family applies to the overseers of the poor for assistance, and they, being unable to refuse, are likely to expend five or six dollars. Total results, leaving out the moral deterioration of Smith and his family, nine dollars profit to the liquor-seller, costs of prosecution paid by the county, Smith and his family supported at the expense of the town and county for ten days, and Smith's productive labor for ten days lost to the community.

At the least calculation, in order that the liquor-seller may make his profit, the community has lost much more than an equal amount. In this instance I have supposed the liquor-buyer to spend a full week's wages, but the contrast is still greater if we suppose, as is more frequently the case, that the buyer has only money sufficient to buy liquor enough to cause his intoxication ; that he is arrested and committed to jail for non-payment of fine and costs. The county then has the costs to pay, and the liquor-seller's profit is only a very small percentage of the expense he has caused the community. Let us attack his profit, wherever his trade is injurious to the public, and we shall be in a fair way to drive him out of the business altogether, or to oblige him to exercise such care in his management as to deprive it of its harm.

The first effect arising from the use of intoxicating liquor is drunkenness. It is proper that this offense against decency should be punished. Let the liquor-seller pay the expense of inflicting such punish-

ment, not the county. The next effect, following from numerous repetitions of the offense of drunkenness, is that the habitual drinker becomes the common drunkard. Whenever he is proceeded against let the liquor-seller pay not only the costs of the prosecution, but also those charges for his detention and support which the place of his settlement is now required to pay. As to the connection between crime and drunkenness as cause and effect I am not entirely certain. There is much to be said in favor of the view that the drunkard and the criminal are liable to be one and the same because the moral diathesis that tends to drunkenness also tends to crime ; that intemperance and crime are coefficients, and that the criminal impulse is not the offspring of intemperance. There can be no doubt, however, that vastly the greater part of the abject poverty that requires the intervention of public assistance is the result of intemperance. For the purposes of the present discussion I claim that it all is. All such poverty the liquor-seller should be required to relieve.

There are, then, three classes of expenses thrown upon the community which arise as the direct result of the use of intoxicating liquor, and indirectly from its sale : the expense of prosecuting simple drunkenness, the expense of prosecuting and maintaining common drunkards, and the expense of supporting the poor; and these expenses should be placed where they belong—on the liquor-seller.

The plan, then, would be to grant licenses for the sale of intoxicating liquors to all applicants who are able to furnish bonds in a sufficient sum to pay their respective shares of the expenses mentioned as assessed upon them at the close of the year for which the licenses are granted. Whenever a person is prosecuted for simple drunkenness and is unable to pay the fine, an effort should be made to induce him, by a remission of a portion of his term of imprisonment or otherwise, to disclose the person from whom he purchased his liquor. His disclosure should become of record in the case. Whenever a person is proceeded against as a common drunkard, the place to which he has habitually resorted should be ascertained in the same way, if possible. After the end of the year for which licenses have been granted, the apportionment of the sums to be paid by every liquor-seller should be referred to some tribunal, which should examine the record in all prosecutions named above, should ascertain the costs of such prosecutions, and the expenses of supporting the poor throughout the district over which it is given jurisdiction. It should have power to apportion the sums to which such costs and expenses amount among all the licensees in such parts as seem to them, after hearing the parties interested, justly proportioned to the expenses which they have severally occasioned. How this tribunal should be formed is not now a matter necessary to be discussed, but it should probably not have a less extended jurisdiction territorially than a county. It might be composed of the county commissioners and one or more of the police magistrates.

Other ways of accumulating evidence, in addition to the disclosures of defendants, could be made use of, such, for instance, as recording the location of all arrests for drunkenness; and it might even be well to provide that, in the lack of other evidence, the costs of any arrest and the succeeding prosecution may be set to the nearest licensed place of sale.

It may be claimed that the tribunal to make the apportionment will have a very difficult and invidious task to perform. Difficult it will be, but no more so than the task imposed upon juries in most of the cases contested before them, and invidious so far as the persons liable to pay are concerned. But there are two things clearly ascertained at the start, to wit, the persons liable to be assessed, and the amount for which they are liable. It must be remembered, also, that the tribunal will have the assistance of all the defendants themselves, who will be the very best witnesses in the matter, for every one of them will be anxious to tell all he knows about the others, in order that his own assessment may be as light as possible. There can be no common defense. The army of liquor-sellers will be divided against itself, and no longer united against the public. Combinations for and against legislation and the employment of counsel to obstruct the administration of the law will become useless.

One of the stock arguments in favor of license is that the lincensees in the interests of their own business will be vigilant to prevent sales by unlicensed persons. Experience has shown, I think, that this expectation has not been confirmed by the facts. The licensed seller is given permission to carry on a profitable business, in which all others are forbidden to engage under severe penalties, and this business is so profitable and the penalties are so effectual that it is never worth while for him to go to the trouble and expense of attempting to suppress the unlicensed dealer. He is entirely content with what the public will do for him in this direction. Under the plan proposed the suppression of the unlicensed seller becomes vitally important to the licensed, for the latter will be obliged to undergo the expenses occasioned by the former, in the same manner that the public now sustains the expenses occasioned by them both.

To recapitulate, in short:

Prohibitory laws have never wholly prohibited in fact, and are objectionable to many persons favorable to the cause of temperance on grounds involving the fundamental principles of legislation.

Under license laws we have a privileged class protected by the public in the exclusive conduct of a business which leads to burdens and expenses, which the public assumes, in effect saying to the licensees, "Go, and for your profit do us all the injury you please or find convenient, and we will not only pay the bills, but we will take care that no one interferes with you."

Under the plan proposed, the burdens and expenses arising from

the use of intoxicating liquor are placed where they belong—that is to say, on those who undertake to make a profit from supplying it; and they are under inducements to reduce such burdens and expenses to a minimum. It may be that no one will be willing to take the risk of engaging in the business with these liabilities, but for this I care not, for we should then have an unobjectionable form of prohibition.

ARISTOTLE AS A ZOÖLOGIST.

By FREDERIK A. FERNALD.

FOR over twenty centuries the philosophical writings of Aristotle have sustained his reputation as one of the greatest thinkers that the world has ever seen. Although he is generally thought of as a metaphysician and a logician, these names by no means denote the whole field of his labors. It was common for scholars in his age to take all knowledge for their province, and the limited attainments of the time allowed one writer to produce exhaustive treatises on every branch. To discover and state the laws of deduction with a completeness and accuracy which have left nothing to be added or taken away since would seem to be a sufficient labor for one man; but, besides doing this, Aristotle wrote considerable works on ethics, politics, rhetoric, physics, astronomy, physiology, and zoölogy. There is not the same unanimity, however, in estimating his scientific achievements as in the opinion of his writings on logic and speculative philosophy.

Aristotle's "History of Animals," says Buffon, "is, perhaps, even now the best work of its kind; he probably knew animals better, and under more general views, than we do now. Although the moderns have added their discoveries to those of the ancients, I do not believe that we have many works on natural history that we can place above those of Aristotle and Pliny." The laudatory language of the illustrious Cuvier is equally strong. Of the "History of Animals" he writes: "I can not read this book without being ravished with astonishment. Indeed, it is impossible to conceive how a single man was able to collect and compare the multitude of particular facts implied in the numerous general rules and aphorisms contained in this work, and of which his predecessors never had any idea." Again, "Not only did he know a great number of species, but he studied and described them after a vast and luminous plan which, perhaps, none of his successors have approached. . . . Everywhere Aristotle observes facts with attention." On the other hand, Lewes, in his essay on Aristotle, says: "It is difficult to speak of Aristotle without exaggeration—he is felt to be so mighty, and is known to be so wrong. History, surveying the whole scope of his pretensions, gazes on him with

wonder. Science, challenging these separate pretensions, and testing their results, regards them with indifference—an indifference only exasperated into antagonism by the clamorous urgency of unauthenticated praise. It is difficult to direct the opposing streams of criticism into the broad, equable current of a calm appreciation, because the splendor of his fame perpetuates the memory of his failure, and to be just we must appreciate both. His intellect was piercing and comprehensive; his attainments surpassed those of every known philosopher; his influence has only been exceeded by the great founders of religions. Nevertheless, if we now estimate the product of his labors in the discovery of positive truths, it appears insignificant when not erroneous. None of the great germinal discoveries in science are due to him or to his disciples." The question to be decided does not concern Aristotle's splendid and perhaps unrivaled genius, his logical power of thought, his love of truth, and his extraordinary diligence; it has reference to the claim made by Aristotle's too ardent panegyrists, that he discovered a system so perfect as to leave little, if anything, for us to alter, that in several instances he anticipated modern discoveries, and that his descriptions are marvels of accuracy and research. How far such statements are true must be discovered by the simple test of reading Aristotle's own words, and for this purpose some of the extracts employed to illustrate a recent comparison of the above conflicting opinions in the "Edinburgh Review" will be instructive.

Let us inquire how far Cuvier's statement that "everywhere Aristotle observes facts with attention" is true. In describing the elephant, Aristotle tells many things correctly, but some very incorrectly, so that it is a question whether he ever saw this animal in his life. He affirms that it has no nails on its toes, though he correctly refers to the toes, which are scarcely distinguished. The nails of the elephant are one of the "points" which the natives of India always regarded as marks of a well-bred animal, and are usually conspicuous. Let us take another point, the "gray-headed error" that the elephant has no joints. Aristotle says, "The elephant is not so constructed as to be unable to sit down and bend his legs, as some persons have said, but from his great weight he is unable to bend them on both sides at once, but leans either to the right side or the left, and sleeps in this position." That is to say, the elephant, having bent one fore-leg, can not then bend the other so as to kneel with both, which is contrary to fact. Although in this passage Aristotle demolishes the absurd statement that the elephant has no knee-joints, yet, in his treatise on the "Progressive Motions of Animals," he seems to leave the matter in doubt. After showing that without inflection there can be no progression, he says: "Progression, however, is possible without inflection of the leg, in the same manner as infants creep; and there is an ancient story of this kind about elephants, which is not true, for such animals move because inflection takes place in their shoulder-blades or hips." The

existence of animals without knees is again supposed by this remark: "Since the members are equal, inflection must be made in the knee, or in some joint, if the animal that walks is destitute of knees." If Aristotle had ever seen an elephant move, is it not probable that he would have spoken more decidedly and correctly on these points? But the most astonishing assertion is that "the elephant can not swim on account of the weight of its body"!

Aristotle's account of the camel is, on the whole, graphic and correct; he describes both the one-humped Arabian and the Bactrian species. He mentions the walk of the camel, stating that it moves with the hind-foot following the fore-foot on the same side. He twice repeats the statement that the camel has no teeth in the upper jaw. Doubtless he alludes to the front teeth; but the camel has two incisors in the upper jaw and two canines, so that Aristotle has not, as Cuvier asserts, "perfectly described and characterized the two species of camel." Among other strange notions held by Aristotle, apparently without any misgivings, may be mentioned the lion having no cervical vertebræ, but only one bone in the neck, its bones, which are small and slight, being without marrow, except a little in the thigh and fore-leg. In his work on "Parts of Animals," he joins wolves with lions in having one neck-bone, and gives as a reason, "Nature saw that these animals wanted the neck more for strength than for other purposes." Aristotle's notions with respect to the skull are peculiar; the brain is placed beneath the sinciput, and the occiput is empty—an error twice repeated. Women's skulls have only one suture, in the form of a circle. He mentions as an extraordinary thing the fact of a man's skull having once been seen without any suture, copying Herodotus in this, who says such a skull was found on the battle-field of Platæa. The skull-sutures in aged persons are frequently obliterated. Again, "The cranium of the dog consists of a single bone." He must have got hold of an old specimen. Certain abnormal deposits of bone which occasionally are found with diseased conditions of the heart in some of the mammalia were considered as necessary organs in the horse and some kind of oxen, "which on account of their large size have a bony heart for the sake of support." The seal and some swine are said to have no gall-bladder. The gall-bladder is by no means constant in the mammalia, and Aristotle is correct in saying it is not present in the elephant, stag, horse, ass, and mule. It is difficult to know what he means when he says that the Achaïnian stags appear to have a gall in the tail; we are quite in the dark as to what these stags are. In another place he mentions a stag of the same kind, which when captured was found to have a considerable quantity of green ivy growing on its horns as on green wood. Buffon seems to have thought this story possible.

That Aristotle placed too much reliance on the marvelous and impossible animal lore current in his age is obvious. Speaking of the

male stag shedding his horns he writes, "It is said that the left horn has never yet been seen, for the animal hides it because it has some medical properties." "When stags are bitten by the phalangium or other such creature, they collect a number of crabs and eat them." These statements are made by Aristotle without a single hint that he does not believe them. Had he regarded them as fabulous, it is probable that he would have so intimated, as he is in the habit of doing when he regards stories as "unworthy of credit." Mr. Lewes mentions Cuvier's instancing four generalizations to prove the immense acquaintance Aristotle must have had with particulars, and adds: "I will quote four others (forty might be found), all taken from the first book, which exemplify plainly enough how easily large and careful induction could be dispensed with: 1. The lion has no cervical vertebræ, but a single bone in its neck. 2. Long-lived persons have one or two lines which extend through the whole hand; short-lived persons have two lines, and these do not extend through the whole hand. 3. Man has, in proportion to his size, the largest and the moistest brain. 4. The forehead is large in stupid men, small in lively men, broad in men predisposed to insanity, and round in high-spirited men."

Aristotle's account of the halcyon, or kingfisher, is a curious mixture of fact and fiction, the latter largely predominating. He gives a good popular description of the bird, but says also: "Birds generally breed in the spring and the beginning of summer, but the kingfisher is an exception, for it produces its young about the time of the winter solstice; wherefore fine days which happen at this season are called halcyon days, seven days before the solstice and seven days after it, as Simonides has written, as when Jupiter in the winter month prepares fourteen days, which mortals call the windless season, the sacred nurse of the variegated halcyon. . . . These halcyon days do not always happen in this country at the season of the solstice, but they nearly always occur in the Sicilian Sea." He has some curious stories about eagles, and here, too, seems to depend upon the poets: "The eagle lays three eggs, but hatches only two, as is also related in the poems of Musæus, 'the bird which lays three eggs, hatches two and cares only for one.' Such things often occur, yet even three young ones have been seen in the nest. . . . The sea-eagle is very quick-sighted, and compels its young ones while still naked to look at the sun, and if one of them will not do so it beats it and turns it round; and the young one which first weeps it kills, the other it rears."

Among other curious zoölogical statements of Aristotle's which seem to receive his support, and which may be set down as current folk-lore of his time, are the following: "If any one make a noise as grasshoppers fly along, they emit a kind of moisture, as agriculturists say. They feed on dew, and if a person advances to them bending his finger and then straightening it, they will remain more quiet than if the finger is put out straight at once, and will climb up the finger,

for from bad sight they ascend it as if it were a moving leaf." "Persons who have parasites in the head are less subject to headache. Moths are produced in the greatest abundance if a spider is shut up with them in the wool, for this creature being thirsty dries up any moisture which may be present. Small birds during the day fly round the owl—which is called admiring it—and as they fly round it they pluck out its feathers." "The anthus" (some bright-colored bird) "is an enemy to the horse, for it drives the horse from its pasture and eats the grass; it imitates the voice of the horse and frightens it by flying at it, but when the horse catches it he kills it." "If any one takes hold of a she-goat by the long hairs of the beard, all the others stand still as if bewildered and gaze at her." "The hawk, though carnivorous, does not eat the hearts of the birds it has killed." "The jay has many varieties of voice; it utters a different one, so to speak, every day." "The goat-sucker flies against the she-goats and sucks them, whence its name. They say that, after the udder has been sucked, it becomes dry and goes blind." "Mares become less ardent and more gentle if their manes are cut. At certain times they never run to the east or west, always north or south." "The sow gives the first teat to the first little pig that is born." "When a serpent has taken its food, it draws itself up till it stands erect upon its tail."

Aristotle's reasons are frequently amusing. Man has no tail because the available formative material has been used up for the posterior parts. Apes have neither tail nor buttocks because they are intermediate between man and quadrupeds. Bees and wasps have stings inside their bodies because they have wings. All crabs and lobsters (generally) have the large claw on the right, because all animals are by nature strong on the right side. Bees and ants are more intelligent than other animals of the kind, because their blood is thin and cold. The seal has no external ears, only ear-pores, because its feet are incapacitated for walking. Serpents have a forked tongue because they are gluttonous, and a bifid tongue has a double tasting power. Man is the only animal that is tickled, because his skin is fine; and he is the only animal that laughs, and tickling is "laughter from a motion of this kind about the arm-pit," which, as Mr. Lewes says, is "a physiological explanation rather difficult to understand." Insects eat little because their bodies are cold. It is curious to notice that Aristotle had no idea that insects produced eggs; he said they bring forth worms, evidently taking the larva stage for the normal birth-form.

These instances are taken from the treatise on "Parts of Animals." It would be easy to supply many more of the same character, but surely these may incline us to deny that "in his accumulation of facts Aristotle has not written one useless word." It is certain from Aristotle's remarks, here and there, that he occasionally dissected animals, but he also mentions anatomical drawings as existing in his time, and

refers his readers to them. He could not, however, have dissected to any great extent, or he would not have made the erroneous assertions that he has on many points not difficult of demonstration. It seems to be chiefly among marine animals that he practiced dissection, and to which he paid most personal attention; certainly, many of his observations on sponges, crustacea, cephalopoda, and other sea-creatures, are admirably correct. To the question, did Aristotle dissect human bodies? his many misstatements seem to require a negative answer; at any rate, as Mr. Lewes remarks, "An answer in the affirmative would be still more damaging to his reputation, since it would render many of his errors unpardonable."

There seems much reason to believe that he paid little attention to examining the skeletons of animals, and that his osteological knowledge was very limited. Let us consider what he has recorded of a certain bone, well known to the Greeks as being one much used for dice and some other purposes. "Many cloven-footed animals," he says, "have an astragalus, but no many-toed animals have one, neither has man; the lynx has, as it were, half an astragalus, the lion one in the form of a coil; solid-hoofed animals, with the exception of the Indian ass, have no astragalus; swine have not a well-formed astragalus." The fact is that the hind-feet of all mammals possess this bone, with slight differences in form and relative position with the other tarsal bones, but always preserving its characteristic shape. Aristotle had a theory—a kind of physiological axiom—which led him to infer that certain animals could not have an astragalus, and he did not examine them to verify his theory; he was satisfied that his theory proved his facts, and that there was no need of verification. His argument, gathered from several passages, is mainly as follows: Large animals have in their system much earthy matter, the superabundance of which Nature uses in the formation of teeth, tusks, and horns. In solid-hoofed animals, as the horse, the excess of earthy matter goes to form the hoof, and not horns or tusks as it does in cattle and elephants; and, as this excess is spent in the formation of a solid hoof, such animals have no astragalus, which is only a kind of superadded bone, and would be, in the horse, for instance, a detriment rather than an advantage.

Aristotle had an ardent love and admiration of Nature, and in Nature he always saw the beautiful. He gives expression to this feeling in the following admirable passage from the "Parts of Animals": "Having already treated of these subjects, and given what is our opinion about them, it remains for us now to speak of animated nature, omitting nothing, as far as lies in our power, whether it be ignoble or honorable; for, even in those things which seem less pleasing to our senses in our contemplation of them, Nature, the creator of all things, affords inconceivable pleasures to those able to discover the causes of things and are philosophers by nature. For it would be unexpected and strange, indeed, if, when looking at images of things, we rejoice

when we survey the art that produced them, whether in painting or sculpture, and do not rather love the sight of the actual works of Nature when we are able to discover their causes."

Dr. Ferdinand Hoefer, writing on Aristotle in the "Nouvelle Biographie Universelle," says, "It is the part of men of genius to show equal superiority in every field," and many of Aristotle's eulogists write as if to abate one jot of this thesis would be treason to their idol. They outdo the zealous friend of Miles Standish in

"Praising his virtues, transforming his very defects into virtues,"

and are frequently carried into absurdities. To quote one other instance from Hoefer, "We find among others this remarkable (!) statement, that animate bodies are composed of air and water. As a fact, chemists have shown that all organic bodies are reduced by analysis to the elements of air and water (oxygen, carbon, hydrogen, and nitrogen)." Now Aristotle's notion of elements was that there were four, having respectively the characters of air, water, earth, and fire, or hot moisture, cold moisture, cold dryness, and hot dryness; and he conceived that animal substances combined the qualities of the first two. A glance at the percentage compositions of air, water, and an animal body puts Hoefer's coincidence in a still worse light. A favorite defense of Aristotle is to suggest that the erroneous passages have been interpolated—so sublimely confident are his disciples that Aristotle can not be wrong, and that what is wrong can not be Aristotle. Then, too, we are bidden to consider the state of science in his day. But, unless Aristotle made a decided *advance* on the state of science in his day, why call him a great naturalist? Just how much better he observed and experimented than the writers on natural science who immediately preceded him, it is impossible to say, since their books, to which he often refers, are lost. Certainly, he failed to record any adequate understanding and appreciation of these processes, and the world has had to learn them from later thinkers. His most ardent admirer will not claim to find in his writings an exposition of inductive reasoning to be compared with his exposition of the deductive process. His mind seems to have had such a pre-eminent command and comprehension of deductive reasoning—it was so perfectly adapted to run in deductive grooves, as it were—that it was incapable of more than the most imperfect use or conception of induction. Without a good command of the tools of science—observation, experiment, and induction—his scientific work could not be important.

But the reputation of Aristotle can well afford to dispense with these contested ascriptions. Sufficient remains unimpeachable to vindicate his title to a gigantic intellect, and let no one suppose that they who deny him equal eminence in widely unlike fields can be outdone in their honor of his real genius.

APICULTURE.

By ALLEN PRINGLE.

AMONG the recent industries of rapid growth in this country, bee-culture stands prominent. Of course, as a homely art, bee-keeping is no modern industry, being as old as history; but in its scientific developments it is of recent growth. In these times, when science is properly taking its place at the helm in all departments of human industry and activity, it is not strange that it is promptly assuming the guidance of bee-culture. This is a utilitarian as well as scientific age; and this is why bee-culture is being so rapidly developed, for its extraordinary growth is only in the ratio of its utility. Though known to commerce for twenty-five hundred years, hitherto it has been followed and known, in this country at least, principally as a local industry. But bee-culture, from the soundest economic considerations, ought undoubtedly to become a great national industry fostered and protected by the state. Apiculture is naturally a part of, and closely allied with, agriculture, inasmuch as the nectar gathered by the one is immediately derived from the same fields and forests that yield the abundant ingatherings of the other. Indeed, the bulk of the honey-crop of this country (which is, in round numbers, about 100,000,000 pounds annually) comes from the bee-keeping which is in connection, more or less, with farming.

But this is not the principal reason why bee-culture must take rank as an important national industry. The postulate is fully warranted by the following fact or facts: When the agriculturist takes his grain to market, he takes with it more or less of the *fertility of his soil;* when he takes his stock and dairy products to market, he does the same thing, only, perhaps, in a less degree. But, when he takes his honey to market, he does nothing of this kind—he takes none of the fertile elements of his soil along with it. When the skilled apiarist, guided by science, so controls, directs, and manipulates his bees that they gather the rich nectar in tons from a given area, representing hundreds and even thousands of dollars, he impoverishes neither his own land nor that of his neighbor: he simply secures that which, if not gathered, "wastes its sweetness on the desert air." Likewise, when a country exports its surplus grain or stock, it also inevitably parts with more or less of its fundamental agricultural resources; but its exported honey-surplus represents no corresponding impoverishment of soil. It would therefore seem clear that, from economic considerations alone, bee-culture ought to and must take its place among the most useful and important national industries.

There is also an æsthetic and hygienic side to apiculture, though in this practical and materialistic age mere sentiment must be subordi-

nated to utility. But the more advanced scientific bee-keeping of to-day may, without assuming much license or latitude, be called "one of the fine arts." To the cultured and æsthetic devotee of art proper in the recesses of his studio, who has never practically studied the nature and habits of the wonderful little honey-bee, and manipulated it from day to day, this claim for our beloved art may excite a smile. Nevertheless, the apiarian devotee who has studied, observed, and handled the marvelous denizens of his hives for twenty years will affirm his art, no less than the flavor of the nectar it produces, to be indeed *fine*. Ladies of high culture and refined tastes are engaged (and successfully too) in bee-culture with all the enthusiasm which is naturally inspired by a congenial and ennobling pursuit; and this is the best proof of our contention as to its æsthetic status. Being withal a healthful occupation, bee-culture invitingly offers itself to those in delicate health and not strong enough for hard physical labor. In numerous instances such persons, by engaging in this pursuit, have not only procured liberal means of subsistence, but have also recovered lost health and strength. The capital required is comparatively small, while the average return for skilled exertion is large. Hardly any other legitimate business yields so large a return in dollars and cents for the amount invested and the work bestowed. True, bee-keeping has its formidable obstacles and serious drawbacks; but these, while sometimes troublesome to the scientific apiarist, are disastrous mostly to the unskillful or negligent, or the mere neophyte. And even though the cargo of industry sink, not much treasure in money or labor is carried to the bottom, while a very little capital added to the valuable lesson of failure soon sets the redoubtable amateur on his legs again.

The honey-bee—which belongs to the general branch of the animal kingdom called *Articulates*, and to the class *Insecta*, and to the subclass *Hexapoda*, and to the order *Hymenoptera*, and the family *Apidæ*, and genus *Apis*, and species *Apis mellifica*—is one of the most intensely interesting studies in the whole domain of natural history. When the immortal Darwin had the scientific zeal and patience to study the apparently insignificant *earth-worm* for *forty* long years, leaving a field untouched for thirty years for the purpose of studying and observing the habits of these despised creatures, how comparatively easy and pleasant to study the honey-bee, which is so much more useful and beautiful! The fact that the honey-bee is so much more serviceable to man than many others of the lower creatures whose nature and habits are equally wonderful, as the ant, for instance, invests it with a double interest to us. Insects which are pests, no matter how marvelous in structure and habit, we can not study with that intense pleasure and interest we can those that yield so much to our physical as well as mental gratification.

Of the species *Apis mellifica* there are many varieties—the principal of which are the Ligurian or Italian bee; the German or black

bee; the Syrian bee; the Cyprian bee; the yellow, Egyptian bee; the amiable, Carniolan bee, of Africa; the superbly beautiful Dalmatian bee; the Smyrnian bee, very popular in Austria; and the stingless bees of South America.

In this country (i. e., Canada and the United States) we have principally the German and Italian bees; but within the past five years the Syrian and Cyprian varieties have been extensively imported into this country by that distinguished and enterprising apiarist, D. A. Jones, of Beeton, Ontario. As the genus *Apis* is not indigenous to this continent, all now existing here have been introduced from the Eastern Hemisphere—first, the black and Ligurian races, and latterly the Eastern varieties.

Each of the varieties now in this country (vying for "survival" as the "fittest") has its distinguishing characteristics. So far, however, the Italians seem to possess more good points and desirable qualities than any of the other races, and hence are the most numerous and popular among advanced apiarists. Their chief distinguishing qualities are superior amiability, industry, and what may be called patriotism, or indomitable energy in defending their homes against invaders, such as robber bees and the "bee-moth"—against both of which they are quite invincible. While different strains of this variety vary considerably in color, they are in general distinguished by three beautiful yellow bands across the abdomen. They also have longer tongues than the German bees, by which they are enabled to sip the nectar from places inaccessible to their less favored competitors. A. J. Cook, Entomological Professor in the Michigan Agricultural College, who has done very much to advance scientific bee-culture in the United States, says on this point, "The tongue of the black worker I have found, by repeated dissections and comparisons, made both by myself and by my pupils, is shorter than that of the Italian worker, and generally less hairy."* In confirmation of this fact, established by Professor Cook's dissections, I have frequently noticed my Italian bees, during a scarcity of honey from other sources, working upon the second bloom of the common red clover (not the *Trifolium pratense*, which the black bee can readily work upon), when the German bees were doing nothing on it, the flower tubes being too long for their tongues.

The black bees (or rather, German, for in point of fact they are not black in color, but a gray-black) have some desirable qualities, though they are now being rapidly superseded by the Italians. They produce nicer comb-honey than the Italians, or perhaps any other race. The proverbial whiteness and finish of their comb are due mostly to the extra *capping*.

For the Syrian races of bees, Mr. Jones and some other leading apiarists claim some superior qualities. I am inclined to think the

* "Bee-Keeper's Guide," ninth edition, p. 35.

Syrian queens (Palestine strain), crossed with the Italian drones, will presently prove to be our very best bees—combining more good points than any other existing variety. Doubtless, however, the bee of the future will be greatly superior to anything we have at present. For purposes of experimentation in developing such, we have now in America several of the best varieties in existence under domestication. By judicious crossing, in accordance with the well-known laws of *variation* and *heredity*, such a result is quite certain. The vast improvement made in this way among our domestic animals, within less than half a century, fully warrants the conclusion that, in the evolution of things so palpable everywhere, we may in the case of our bees subsidize and utilize the same ever-acting law of progress.

Following the Syrians, and genealogically closely allied to them, we have the Cyprians, though not yet widely diffused. They resemble the Italians, of which they are supposed to be the progenitors. The Cyprian bees have some good points, and one very bad *point*. They are famous for their fecundity, but equally *in*famous for their ferocity, being maliciously expert in using very pointed stings. This variety (unless in this inspiriting western atmosphere it acquires more amiability) is not likely to become popular, notwithstanding the marvelous fecundity of the queens. It may be possible, by crossing with some bee of good disposition, to mollify their bad tempers and retain their good qualities.

Of the remaining varieties of the honey-bee, and sub-varieties, including *hybrids*, little is practically known in this country, with the exception of one or two strains of the latter. The "hybrids," resulting from a cross between the Italian queen and the German drone, are well known in Canada and the United States, and, next to the pure Germans and Italians, are perhaps most numerous. These hybrids have excellent qualities: they make superb comb; are active and energetic; and I have observed stand the rigor of our Canadian winters much better than the pure Italians; but they are much less amiable.

A properly constituted colony of bees consists of three different kinds, viz.: an impregnated *queen* (the fully developed female); *drones* (the males); and *workers* (undeveloped females). The queen (absurdly called the "king-bee" from the time of Aristotle and even Virgil down to Huber) is the mother of the whole colony, and is capable of laying over three thousand eggs per day! During the height of the breeding-season in the honey-flow, she frequently lays from two to three thousand eggs per day for many consecutive days together. She remains prolific for from two to four years, and in some instances queens have been known to remain prolific upward of five years. Before the queen-bee of a colony becomes quite barren, and while she is still laying, if not removed by the apiarist, the workers themselves supersede her, by killing her and rearing a young

queen to take her place. Sometimes, however, the old, worn-out mother is permitted to remain in the hive while the young one is being reared, and ultimately dies of neglect and depression, or is assisted to "shuffle off" by her own unfilial progeny. The queen is reared from the same egg as the worker, but in a much larger cell, nearly perpendicular, and on different food, called "royal jelly," which has the effect of fully developing the sexual apparatus. The time from the egg to the perfect queen emerged from the cell is about sixteen days. In a few days after hatching, the young queen leaves the hive for her "bridal flight," during which, and on the wing, she meets the male bee or drone in copulation and becomes impregnated, when she returns to the hive to remain there until she leads out the first swarm, which she does when she finds young queens being reared in the hive—one of them designed to take her place. A *single* fertile queen in a colony is the normal condition of the household, and hence the old queen departs to make room for her successor. Second and third swarms are of course led out by the young queens. With the exception of sometimes attacking and destroying inchoate queens, the sole function of the queen is to deposit eggs and lead out the first swarm. After her impregnation she deposits both drone and worker eggs—either kind at pleasure. She is capable, however, as a virgin queen, of laying fertile drone, but not worker, eggs. This apparently anomalous fact (*parthenogenesis*) is now well established, not only in the case of the virgin queen-bee, but in that of several other insects. Sometimes *worker*-bees in queenless colonies lay fertile drone-eggs; but the queen is the only fully developed female in the colony.

The worker-bees, though "the bone and sinew" of the hive, are not blest with the queen's longevity. In active work, on the wing and off, during the honey-season, they naturally live but a few weeks—from one to two months—while those hatched late in the fall will live until spring, sometimes reaching the age of nine months and upward, which is the maximum longevity of the worker-bee. In passing from the egg to the perfect bee, the worker occupies twenty-one days. The young worker spends several days (from ten to fifteen) at home building comb, attending to the young brood, receiving and depositing the loads of the outside workers, and sundry other little duties, before it ventures to the fields to work. The duties of the older workers of the colony are to gather honey, pollen, and propolis, destroy and cast out the drones when necessary, and defend the colony from enemies without or within. They also, as already noticed, destroy old, unprolific queens and rear young ones to take their places, and sometimes lead out in swarming, as the queen does not always take the lead in swarming. And although very young bees are ordinarily very reluctant to leave the hive, I have seen such rush out under the swarming impulse so young that they couldn't fly more than a foot or two, if at all. They usually crawl back home again in apparent disgust

with the outside world, and doubtless with more wisdom and less conceit.

The third and last rightful denizen of a perfect colony of bees is the unsophisticated, stingless, but much abused *drone*—the male bee. He is well named, however, being a very liberal feeder with excellent digestive organs for honey, and with no duties whatever within the hive further than the incidental one of contributing by the presence of his cumbrous corporation to the animal heat of the hive. As to his natural longevity, nobody from Virgil to Huber, Langstroth, Quinby, Newman, Cook, Jones, *et alii*, seems to know much about it. The matter not being invested with any importance, no investigator seems to have bothered his head much with it. So far as I could ever see, the drone seems to live and thrive admirably until he is either killed off by the workers, starved to death, or gallantly yields up his life in performing his sole function, which he invariably does in the performance of this function in the act of copulation. The drone, as Dr. Dzeirzon established, comes from an unimpregnated egg—the virgin queen, and sometimes even workers, being able to lay eggs which will produce drones. As a rule, drones are found in colonies whenever they are needed, or likely to be needed to impregnate the young queens, which is usually during the swarming season and honey-harvest. Though they are promptly ejected from strong colonies when not needed, and the honey-flow fails, they are tolerated in queenless colonies, and are sometimes wintered over. The drone is much larger than the worker, and his cell very protuberant, and in it he spends twenty-four days from the egg before he emerges.

As remarked at the outset, bee-culture made but little progress on scientific principles for thousands of years. It is only within the last half-century or so that it has, under the magical talisman of science, fairly leaped forward like every other pursuit. The first great achievement was the application of the centrifugal force in the construction of the honey-extractor, thus enabling us to get the honey in its purity out of the comb without injuring the latter, when it can be returned to the bees to be refilled. A German (Herr von Aruschka) accomplished this, and thereby gave a great impetus to bee-culture. Indeed, the invention of the *movable frame* and the *honey-extractor* completely revolutionized the *modus operandi* of bee-keeping. As to who is really entitled to the credit of inventing the movable frame, there is some uncertainty and a conflict of claims. The truth seems to be that some three or four different persons are fairly entitled to credit—each, it would appear, having conceived and developed the idea, more or less independently of the others. Huber and Schmidt in Germany, Munn in England, M. de Beauvoys in France, and Langstroth in the United States, are all fairly though not equally entitled to credit, and each has placed progressive bee-culture under tribute. Mr. Langstroth, however, seems entitled to much more credit than any of the others,

for his hive had more practical value than the whole of the others together. In carrying out the common principle, Langstroth was undoubtedly far ahead.

The next stride in advance was the invention of the manufacture of "comb-foundation," which was a great desideratum, as the honey-season in the temperate zone is comparatively short, and a new colony of bees supplied with the "comb-foundation" will do as much in two or three days as one alongside of it without the foundation will do in eight or ten days, as the writer has repeatedly proved. Foundation-comb is made by pressing sheets of pure bees-wax between metal rollers or plates so constructed as to give to the wax the exact impressions of the cells in the basal wall of the natural comb. This saves the worker-bees just that much labor and time, and they proceed at once to rapidly draw out and develop the incipient cells. The merit of this invention is also somewhat in dispute. Upward of twenty years ago the late eminent apiarist, S. Wagner, patented comb-foundation in the United States; but it soon transpired that Herr Mehring, in Germany, had previously made foundation, and that the Germans had been using it for three or four years. As it is the accumulated wit and experience of the age, rather than the man, that produces the invention, it is quite likely that Mr. Wagner arrived at the idea without the aid of the other German (for Mr. Wagner was himself a German). Montaigne said he "had as clear a right to think Plato's thoughts as Plato himself had"; and the American German had not only as good a right as the home Teuton to think out this invention, but he was just as likely to do so, and more likely, for the inspiriting and inventive Yankee atmosphere would quicken his blood and sharpen his wits.

Recent bee-culture has been also greatly promoted and extended by the specialty of queen-rearing, which has been brought to great perfection on scientific principles. D. A. Jones, in Canada, and Henry Alley, in the United States, have developed this department of apiculture to an extent leaving, one would think, little to be further achieved or desired. As, however, under the progressive laws of evolution, we have ceased to set bounds to improvement in anything not fixed mathematically, we will not say that any department of practical apiculture is yet fully wrought out to perfection.

In order to secure absolute purity of fertilization in the different varieties and sub-varieties in crossing, D. A. Jones, of Beeton, Ontario, has established queen-nurseries on different islands in Georgian Bay, so far from shore and from each other as to secure entire purity of blood in copulation. Queens and drones bred and mated under such circumstances, from pure imported stock, can not be otherwise than pure.

Henry Alley also, of Wenham, Massachusetts, has, through a long series of experiments during many years, successfully applied science to the *modus operandi* of queen-rearing, and has recently given the

world the fruits of his labors and researches in a work entitled "The Bee-Keeper's Handy-Book; or, Twenty-two Years' Experience in Queen-Rearing."

Another feature of present bee-culture, which is at once both largely the cause of its present advanced condition in this country and the best proof of its wide extension, is its periodical literature. Devoted wholly or partially to apiculture, we now have no less than three or four papers in Canada, and nearly a dozen in the United States. Among the latter is one *weekly* devoted *exclusively* to bee-culture. This is the "American Bee Journal," published in Chicago by Thomas G. Newman. Among the former is the "Canadian Bee Journal," a weekly, just commenced under the most favorable and promising auspices. It is edited and published by D. A. Jones, of Beeton, Ontario.

Since the hitherto great difficulty of successfully wintering bees in these climates has been nearly overcome by the application of science, bee-culture must, in the near future, become a great and profitable national industry in Canada and the United States.

STRUCTURE AND DIVISION OF THE ORGANIC CELL.

By CHARLES MORRIS.

THE doctrine of the cell, as the unit of vegetable and animal structure, has been constantly varying in its details since its first proposal by Schleiden in 1837 and Schwamm in 1839. It was at first held that the cell was a microscopic vesicle, globular in its typical form, bounded by a firm membranous wall, and inclosing fluid or semi-fluid contents. In its interior lay a smaller vesicle called the nucleus, which occasionally held a minute mass called the nucleolus. The cell-wall was believed to be its active constituent, which selected materials from the surrounding fluid for cell-nutrition, and set up physical and chemical changes within its contents. At a later date Goodsir and Barry maintained that the nucleus was the active agent in these processes, and that self-division of the nucleus was the source of cell-division. It was also perceived that a cell-wall was by no means always present, and Leydig defined a cell as "a little mass of soft substance inclosing a nucleus." A more important step of progress was made about 1861, when Von Mohl, Brücke, Max Schultze, Beale, and others, propounded their views upon the subject. Brücke pointed out that the contents of cells frequently displayed spontaneous movement and contractile power; and Max Schultze declared that sarcode—the contractile substance which forms a large part of the bodies of the lower animals—was homologous with the contents of actively growing cells. Von Mohl had proposed the term protoplasm to designate the

active substance of vegetable cells. This term was extended by Max Schultze to embrace all organic cells, and he defined the cell as a nucleated mass of protoplasm. At a still later period it was declared that a nucleus was not always present, and the cell was defined as "a structureless mass of protoplasm."

Such was the stage of the cell-doctrine reached in 1872, thirteen years ago. First the cell-wall had been considered the active element, then the nucleus, and finally the protoplasmic contents, while wall and nucleus came to be considered inessential elements. As Drysdale expressed it about that date, "a cell is like a gun-barrel, without a stock and a lock." Meanwhile Beale had persistently declared that there is no such thing as a cell, in the ordinary sense of the term; but that all organic bodies are made up of minute particles of living or germinal matter, which consume nutriment and increase internally, while their exterior portions lose vital activity, and become dead or formed material. These living particles not only grow, but divide, and thus set up new centers of growth, from which emanates new-formed material.

The division of the cell-protoplasm is, indeed, a most essential part of the life-process, and to it growth and differentiation of tissue are principally due. The cell, when furnished with nutriment, manifests individual growth for a short period. Then it separates into two or more new cells, each of which sets up an individual life. This separation takes place in several methods, of which the most common is by an equatorial constriction, which gradually deepens until it cuts the cell into two sections. Other methods are by the budding off of minute portions from the surface, or the transformation of the cell-contents into many minute germs, which are subsequently set free.

Such was the cell of thirteen years ago—"a structureless mass of protoplasm," which increased in size by nutrition, and in numbers by division. Such is the cell of most of the text-books of to-day. But the cell of science is a very different affair. Instead of being structureless, it is found to possess an intricate structure, while its division is far from being the simple process above indicated. The new cell-theory is, in fact, but five or six years old in its developed form, and it is as yet settled only in its main features. Its minor details need much further elucidation.

These new discoveries, which we shall briefly describe, are largely due to the increased power and clearness of definition of the microscope, and still more to new and improved methods of preparing organic sections for investigation, by the employment of stains, preserving agents, and other useful appliances. It is not every microscopist that is able to see the minute details of cell-structure lately announced. The careful preparation of material and exceedingly delicate manipulation required need years of practice, and the discoveries referred to are due to the first microscopists of the age, though the methods are now so

simplified that any skilled observer, with a good instrument and proper care, may hope to successfully employ them.

The matter of which an organic cell is composed is found to be not simply a homogeneous, or slightly granular, mass of protoplasm. On the contrary, it appears to be traversed in every direction by delicate fibers, which form an intricate network or reticulum. The interstices of this network are occupied by a fluid or semi-fluid substance of homogeneous appearance, though occasionally containing a few small granules. The reticulum occurs not only in the outer cell, but also within the nucleus, and its fibers extend to and are apparently connected with the nucleolus. Within this latter the fibrous formation has not been traced. Some observers, indeed, declare that there is no nucleolus, but that it is simply a node of the intersecting fibers. But this view is not generally entertained, and late writers ascribe to the nucleolus an important function.

In the growth and division of the cell the nucleus appears to be specially active, and the new doctrine known as karyokinesis relates principally to the peculiar metamorphoses of the nucleus during cell-division. Two phases of cell-life are now well marked. One of these is an active stage, during which transformation of the cell-contents rapidly takes place, and division follows. This is succeeded by a resting-stage, in which all activity of the nucleus ceases, the fibers grow less distinct, and a partly homogeneous condition results. This resting-stage is, after a period, followed by a new period of activity.

The behavior of the cell-contents, when treated with carmine or other staining reagents, indicates that they are composed of at least two distinct substances. During the resting-stage this does not appear, for the whole cell takes the stain, though it deepens in the nucleus, and still more in the nucleolus. But during the active stage only the fibers take the stain, while the intermediate ground or basis substance remains clear and transparent. From this difference in behavior the name *chromatin* is proposed for the fibers, *achromatin* for the ground substance.

Flemming, one of the most skillful observers of these phenomena, distinguishes two forms of division—the direct and the indirect. The former—which may eventually prove to have no real existence—is a direct separation, first of the nucleolus, then of the nucleus, and finally of the cell. In the latter there is a peculiar metamorphosis of the nucleus. Flemming, from observation of the cells of Salamandra, describes the process as follows:

The resting-nucleus possesses a faintly-defined reticulum of fibrils, whose meshes hold a homogeneous ground substance, one or more nucleoli, and occasionally a few small granules. Possibly these latter are merely the nodes of the reticulum. When the active stage commences, the membrane of the nucleus disappears, as also the nucleolus and the granules. If the latter are merely nodes of the fibrillar network, we

can understand their disappearance, for the fibrils lose their net-like reticulation, and become an irregular convolution, with no free ends. Around this fibrous nuclear mass appears a clear space, which separates it from the outer cell-substance. As thus arranged it forms what has been called the *aster*.

Soon the fibrous convolutions assume a wreath-like arrangement, with their bends irregularly directed toward a central space. Eventually the wreath loses its continuity, and breaks into a series of short, separate fibers, which form V-shaped loops. The bends of these loops are directed toward the center space, their openings outwardly. This arrangement forms the *mother-star*. Next there is shown a doubtful appearance, as if the fibers had split into two, or had become tubular. The loops are also compressed toward the equatorial plane of the nucleus, and lose their extension toward its polar region. After some further dubious movements, a rearrangement of the loops is found to have taken place, their bends being now turned outward, their openings inward toward the equatorial plane. They have also separated in this plane, so as to form two distinct masses, one on each side of the equator. If we consider the cell as a globe, and the equatorial plane as a circular disk dividing this globe into two hemispheres, then on each side of this disk lies a smaller circle of fibrous loops, which present something of the aspect of a circular basket, or of a partly-opened daisy. The openings of these basket-like figures are turned toward each other, with the equatorial plane separating them. The converging looped ends of the fibers are turned outward.

This stage in the process of division of the nucleus is followed by a recession of the basket-figures. They retreat in the axial line of the cell until they reach the polar regions of the nucleus. Here a rearrangement of the fibrous loops takes place, their bends again become directed toward a central space, and two new stars, similar to the *mother-star*, are formed. The division of the chromatin, or fibrous substance of the nucleus, has become complete, and the whole new arrangement is known as the *dyaster*.

As the basket-like figures recede, there often appear in the interval between them delicate striæ, which cross the equator from pole to pole. This condition, which is most declared in vegetable cells and in segmenting ova, is known as the *nuclear spindle*. The lines of the striæ seem to be composed of achromatin. Other faint lines often radiate from the poles toward the surface of the cell, forming sun-like figures at the extremities of the nuclear spindle. Complete division is preceded by the appearance of a row of dots across the equatorial plane, which seem to be thickenings in the centers of the lines of the spindle. These thickenings are probably composed of chromatin, and form what is called the *equatorial plate*. They soon divide, the spindle separating in its center, while the thickenings appear like minute disks at the extremities of the nuclear striæ. Thus a double equa-

torial plate is formed, inclosing a narrow equatorial plane. This is the plane of cell-division. A furrow appears around the equator of the cell, which deepens, and extends inward between the equatorial plates. It continues to deepen until it finally meets in the center, and the cell is separated into two new ones.

While this is proceeding, new nuclei are forming at the nuclear poles. The fibers of the daughter-stars pass through a series of changes opposite to those above described. The ends of the loops unite until a wreath is formed. This wreath soon becomes an irregular convolution, which quickly assumes the reticular structure. Membranes form around the new nuclei. Nucleoli and granules reappear. The resting-stage is regained. The original cell is replaced by two daughter-cells.

The above description, with its detailed account of the process of cell-division, is not accepted in all its particulars by other observers. There is great diversity of opinion about many points, which can not be settled without much further investigation. It is also very probable that much of the diversity of opinion arises from the fact that the cells of different organisms vary in their features of change, and that vegetable cells only distantly resemble animal cells in this particular.

Some of the unsettled questions are the following: Klein and Strasburger see little importance in the nucleolus. Klein doubts its existence. There is an open question whether it and the granules are not merely the nodes of the network. But the majority of observers speak of the nucleoli and granules as lying free in the ground-substance, in the intervals of the network. It is also a question whether or not the outer cell-substance is like the nucleus in structure. Klein holds that it is. Flemming has lately announced the discovery, in the resting-nucleus, of a very fine network, in connection with the coarser one already known. He also declares that the membrane surrounding the nucleus is really composed of minute flat plates of chromatin continuous with the fibrils of the network. These are separated by slight intervals, so that the membrane seems pierced by holes, which perhaps may be occupied by the transparent ground-substance. Others deny the existence of a nuclear membrane, and think that it is an optical illusion, caused by the arrangement of the fibers. Dr. Pfitzner has recently declared that the chromatin fibrils are not homogeneous in structure, but that they really consist of minute spherules of chromatin, held together by some other substance, probably achromatin.

Such are some of the questions to be yet settled. It would appear that the chromatin of the original nucleus becomes first regularly arranged around its center, then divides equatorially and recedes to its poles, where it forms new nuclei, while the achromatin-fibrils of the spindle may possess some chromatin, which collects upon their centers to form the equatorial plate. If Flemming's last observation concern-

ing the formation of the membrane be correct, it may prove that the disks of the spindle-fibrils are the origin of the cell-wall, and that similar disks arise at the extremities of achromatin-fibrils in the new nuclei to form their membranes. And Pfitzner's observations would indicate that the fibrils are really composed of achromatin, upon which chromatin gathers either continuously or in separate spherules. In such a case the movements of chromatin would be along lines of achromatin; and we can comprehend the appearance of the lines of the achromatin-spindle, after the chromatin has aggregated at the poles, and also of the chromatin-disks which are shown equatorially on these lines. The chromatin of the fibrils has aggregated at the poles and the equator of the nucleus, and left apparent intermediate lines of achromatin.

In vegetable-cell divisions Strasburger finds none of this regular process, but only a vague approach to it in the movements and aggregations of masses of chromatin. But the achromatin-striæ of the nuclear spindle, the equatorial plate, and the sun-like polar rays, are well declared. In some cases of abnormally rapid nutrition a threefold division takes place, and possibly a still greater number of new cells may be formed. The process of cell-budding may be similar to that above described, if we can judge from observations on the early transformation of the ovum. Here a nuclear spindle is formed, with its polar suns. This moves to the surface of the cell, and one of the poles is pushed out through its wall. Constriction takes place, and the new nucleus remains on the outer surface of the cell as the *polar body*, while the other nucleus retreats to the center of the ovum. The process is precisely analogous to ordinary cell-division, the difference being that one of the new nuclei retains around it all the substance of the original cell, while the other is destitute of it. Did this polar body become free, and grow by absorbing new nutriment, the resemblance to ordinary cell-budding would be complete. Frequently two or more polar bodies are thus formed ere fertilization of the ovum takes place. Possibly the cell buds off its male element and retains only its female. An analogous process takes place in the spermatozoa. It would seem as if the germinal cells were becoming specially male and female in energy ere combining to form the germ of a new individual.

Recently Mr. J. M. Macfarlane, of Edinburgh, has published an interesting paper, descriptive of vegetable-cell division. His observations were made on the cells of *Spirogyra*, a common fresh-water alga. The large nuclei of these cells seem specially adapted to observation. He found not only that the nucleolus was very distinct, but that it invariably contained a well-defined body, which he names the *nucleolo-nucleus*. He found this body in all plant-cells examined, and also in cerebellum-cells of animals. In staining with carmine the stain hardly affected the outer cell-substance, the nucleus took a somewhat deeper stain, the nucleolus was deeply colored, and the nucleolo-nucleus still

more deeply. The density of the chromatin appeared to increase inwardly.

From the outer cell-wall fibers pass inward to the nuclear membrane, which they probably penetrate, and become continuous with the fibers of the nucleus. These, in their turn, seem to connect with what appears to be a membrane of the nucleolus. Inside the latter there is no evidence of fibrous structure.

In cell-division the first stage is the aggregation, on opposite sides of the nucleus, in a line with the long axis of the cell, of a quantity of pale, slightly granular protoplasm. This is perhaps derived from the peripheral layer, and travels inward along the fibers, since minute thickenings, of similar appearance, show themselves upon these fibers. The nucleolus swells out into two protuberances, in the same axial line, joined by a bridge of denser matter. This change is, perhaps, connected with the division of the nucleolo-nucleus, since subsequently two of the latter are visible, while the nucleolus returns to its former state. At the same time it is found to have considerably increased in size. The next visible change occurs in the nucleus, whose contents aggregate at the nuclear poles, push through the membrane, and combine with the outer aggregation of protoplasm to form two dark amœboid lumps. From these polar masses fibers run inward and outward, though the external fibers have become loose and flaccid.

In the next stage the nuclear membrane disappears. The spindle of fibers which runs inward to the nucleolus is bordered by two darker strands, possibly the remnants of the membrane. This composes the *nuclear barrel.* The nucleolus divides by a dumb-bell-shaped constriction, similar to what appears in the division of amœbæ. It resembles what Flemming calls "direct division." The two halves of the divided nucleolus—each containing one of the nucleolo-nuclei—now move outward toward the poles, a new line of fibers forming between them as they separate. These bodies almost seem to have a repulsive energy, for the polar masses recede before them. The connecting lines also spread outward centrally, so that the nuclear barrel becomes considerably elongated and widened. It resembles a barrel with thick, narrow ends and widely swelled-out middle. Eventually the nucleoli reach the polar masses, into which they penetrate, while the substance of the latter spreads inward so as to inclose them. The rudiments of new nuclei are thus formed, between which extend rows of fine fibrillar lines, much separated centrally. The "nuclear barrel," with the nucleolus in its center, has thus been succeeded by the "nuclear spindle," with no central mass.

There now appears a row of dots, stretching across the equator of the spindle. This quickly separates into a double row. At the same time the lines of the spindle are sundered centrally, and the dots seem to be minute disks at their extremities. In this manner a double "equatorial plate" is formed, inclosing the circular equatorial plane of

the cell. Around the cell-wall, in this plane, is seen a faint ring, which pushes inward, and develops into a new wall of cellulose. It extends into the space between the two equatorial plates, and continues to grow inward until the center is reached, when it forms the dividing wall of the two new cells. As it grows, the spindle, which had previously been swelling outward, begins to contract, until it becomes a narrow series of lines, reaching from the poles to the new cell-wall. Meanwhile the polar masses secrete new membranes, and assume the condition of nuclei of the new cells. So rapid is the process that the nucleolo-nucleus often again divides ere the nucleus has completed its division, and the nucleoli again divide ere the new cells are formed. Hence the new nucleus often has two nucleoli. After complete division the lines of the nuclear spindle are still apparent. They may, by splitting, give rise to the fibers of the new cells.

Such is a recent description of the process of division in the plant-cell. In the cells of some plants, however, there is a preliminary step of change which does not appear in *Spirogyra*. In these cases division begins with a massing of the nuclear contents in the equatorial region. The nucleus has a spindle-shape, with a dark mass in its center, and clear areas reaching to its poles. This mass splits, and its two halves retreat to the poles. The further steps of division are as above.

Thus, so far as now appears, the process of cell-division in the plant is closely analogous to, though not identical with, that of the animal. It seems, indeed, a more primitive stage of the phenomenon. The division of the nucleolus, so marked in the plant, has not been observed in the animal, and may be, in the latter, suppressed or hastened, like many of the developmental changes in the higher animals. On the other hand, the peculiar movements of the chromatin-fibrils of the animal cell have no direct counterpart in the plant. They seem to present a distinct step forward in cellular evolution, and yield the idea that the animal cell is a more advanced organism than that of the vegetable. It certainly seems to hasten or suppress embryo changes which are well marked in the latter, and to clearly display advanced stages of development which are only vaguely outlined in the latter.

There is another cell-theory extant to which some allusion must be made, as it indicates a final stage in cell-evolution in advance of that here indicated. It is known that in many cases elongations of the fibrous network extend outward from the cell. These have been seen in epithelial cells, joined so as to form a connecting link between two cells. It is well known also that numerous delicate fibrils extend beyond the walls of nerve-ganglion cells, probably as outer continuations of the internal network. It is supposed that these fibrils aggregate into bundles, and that thus the nerve-fibers, which run to all parts of the surface of the body, originate. This seems to be the cell connection of the sensory nerves, while the motor nerves leave the cells each as a single fiber. The nerve terminations of muscles present a

similar condition, since they probably penetrate the cells as minute fibrils.

C. Heitzmann, a skilled microscopist, now of New York, has long maintained, and has recently reiterated, a theory which declares that this fibrillar extension is not confined to epithelial and ganglion cells, but is common to all the cells of the body, and that intimate interconnections between all the cells and tissues are thus made. Even the bony structure he declares to be everywhere permeated by fine channels, in which run fibrils of protoplasm, connecting the granular and nuclear masses throughout the whole substance. He, indeed, denies the existence of separate cells, and claims that the body is simply a vast reticulum, with nuclear masses as nodes of the network. Instead of being composed of numerous separate amœboid cells, it is a single complex amœba.

This bioplasson theory is not accepted by microscopists generally, and it certainly goes too far in denying the existence of distinct cell-structures. It may be possible that it indicates a final stage in the process of cell-evolution. Distinct isolated cells undoubtedly exist in the blood and lymph fluids of the body. But in the more solid tissues this isolation is, in some cases at least, replaced by an interconnection of cells through the medium of inosculating fibrils. And it is quite possible that this fibrillar extension becomes so declared in extreme cases as to produce the appearances described by Heitzmann. The basis or ground-substance of the outer cell of osseous tissue may be converted, by deposition of lime-salts, into bony matter, through which the fibrils extend from the nuclei in open channels. If this theory be correct, the original cell becomes a nuclear center of active protoplasm and an outer region whose ground-substance is converted into bone, while its protoplasmic fibrils extend until they join similar fibrils of other cells, thus converting the whole mass into a living network whose interspaces are occupied with bone.

In other tissues a similar condition may exist, the bony matter of the osseous ground-substance being represented by other inactive material proper to the tissue. Perhaps every phase of differentiation exists, from the completely isolated corpuscles of the liquid tissues to the complete and extended reticular structure described as existing in bone.

This theory naturally leads to some probable speculative views. If, as seems evident, the nerve-fibers originate in such extensions of the intercellular network, possibly the fibrils of individual cells have a conductive or nerve function, as also the contractile or muscle function which some writers ascribe to them. Their extension from cell to cell would indicate nerve communication, and it may be that the undoubted nerve and muscle function of many low animals, in which no nerves and muscles have been discovered, may be due to these interlacing fibrils. And the widely extended nerve-system of the higher

animals, by which the whole body is made one inter-related unit, may be but a final outgrowth of the fibrillar-cell system. The fibril reticulum of the isolated cell becomes the nerve reticulum of the complex body, which is virtually converted into a single cell, with its intricate network of fibers.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XLVIII.—THE WEAR AND TEAR OF THE BODY.

IN the course of these papers I have repeatedly spoken of the nitrogenous and non-nitrogenous constituents of food, assuming that the nitrogenous are the most nutritious, are the plastic or flesh-building materials; and that the non-nitrogenous materials can not build up flesh or bone or nervous matter, can only supply the material of fat, and by their combustion maintain the animal heat.

In doing so I have been treading on loose ground—I may say, on a scientific quicksand. When I first taught practical physiology to children in Edinburgh, many years ago, this part of the subject was much easier to teach than now. The simple and elegant theory of Liebig was then generally accepted, and appeared quite sound.

According to this, every muscular effort is performed at the expense of muscular tissue; every mental effort, at the expense of cerebral tissue; and so on with all the forces of life. This consumption or degradation of tissue demands continual supplies of food for its renewal, and, as all the working organs of the animal are composed of nitrogenous tissue, it is clearly necessary, according to this, that we should be supplied with nitrogenous food to renew them, seeing that the nitrogen of the air can not be assimilated by animals at all.

But, besides doing mechanical and mental work, the animal body is continually giving out heat, and its temperature must be maintained.

* Within the last few years research into the conditions of plant-cells has led to the interesting discovery that these cells are very generally connected by fine fibrils of protoplasm, in a manner somewhat similar to that which Heitzmann declares to be the general rule in animals. Possibly this may prove to be a universal condition. Mr. Walter Gardiner, in a memoir read before the Royal Society, April 26, 1883, says: "Although I am aware of the danger of rushing to conclusions, I can not but remark that when these results—which were foreshadowed by Sachs and Haustein when they discovered the perforation of the sieve-plate—are taken in connection with those of Russow, it appears extremely probable that, not only in the parenchymatous cells of pulvini, in phloem parenchyma, in endosperm-cells, and in the prosenchymatous bast-fibers, is continuity established from cell to cell, but that the phenomenon is of much wider if not of universal occurrence." This condition, so commonly present in plants, has as yet not been widely traced in animals, but may eventually prove to be equally general, as Heitzmann declares. The connecting protoplasmic fibril may be the embryo stage of the nerve-fiber, and may serve to bring every cell in the body within the range of nerve influence.

Food is also demanded for this, and the non-nitrogenous food is the most readily combustible, especially the hydrocarbons, or fats; the carbo-hydrates—starch, sugar, etc.—also, but in lower degree. These, then, were described as fuel-food, or heat-producers.

This view is strongly confirmed by a multitude of familiar facts. Men, horses, and other animals can not do continuous hard work without a supply of nitrogenous food; the harder the work the more they require, and the greater becomes their craving for it. On the other hand, when such food is eaten in large quantities by idle people, they become victims of inflammatory disease, or their health otherwise suffers, according, probably, to whether they assimilate or reject it.

Man is a cosmopolitan as well as an omnivorous animal, and the variation of his natural demand for food in different climates affords very direct support to Liebig's theory. Enormous quantities of hydrocarbon, in the form of fat, are consumed by the Esquimaux and by Europeans when they winter in the Arctic regions. They can not live there without it. In hot climates *some* fuel-food is required, and the milder form of carbo-hydrates is chosen, and found to be most suitable; rice, which is mainly composed of starch, is an example. Sugar, also. Offer an Esquimau a tallow-candle and a rice-pudding, he will reject the latter, and eat the former with great relish.

A multitude of other facts might be stated, all supporting Liebig's theory.

There is one that just occurs to me as I write, which I will state, as it appears to have been hitherto unnoticed. Some organs which act in such wise that we can *see* their mode of action are visibly disintegrated and consumed by their own activity, and may be seen to demand the perpetual renewal described by Liebig. There are certain glands of cellular structure which cast off their terminal cells containing the fluid they secrete; do their work by giving up their own structural substance at their peripheral working surface.

Where, then, is the quicksand? It is here. If muscular and mental work were done at the expense of the nitrogenous muscular and cerebral tissues, the quantity of nitrogen excreted should vary with the amount of work done. This was formerly stated to be the case without hesitation, as the following passage from Carpenter's "Manual of Physiology" (third edition, 1856, page 256) shows: "Every action of the nervous and muscular systems involves the death and decay of a certain amount of the living tissue—as is indicated by the appearance of the products of that decay in the excretions."

More recent experiments by Fick and Wislicenus, Parkes, Houghton, Ranke, Voit, Flint, and others, contradict this by showing that the waste nitrogen varies with the quantity of nitrogenous food that is eaten, but not with the muscular work done. For the details of these experiments I must refer the reader to standard *modern* physiological treatises, as a description of them would carry me too far away

from my immediate subject. (Dr. Pavy's "Treatise on Food" has an introductory chapter on "The Dynamic Relations of Food," in which this subject is clearly treated in sufficient detail for popular reading.)

It is quite the fashion now to rely upon these later experiments; but, for my own part, I am by no means satisfied with them—and for this reason, that the perspiration from the skin and the vapor from the lungs were not examined. It is just these which are greatly increased by exercise, and their quantity is very large, especially those from the skin, which are threefold, viz., the insensible perspiration, which is transpired by the skin as invisible vapor; the sweat, which is liquid; and the solid particles of exuded cuticle.

Lavoisier and Seguin long ago made very laborious experiments upon themselves in order to determine the amount of the insensible perspiration. Seguin inclosed himself in a bag of glazed taffeta, which was tied over him with no other opening than a hole corresponding to his mouth; the edges of this hole were glued to his lips with a mixture of turpentine and pitch. He carefully weighed himself and the bag before and after his inclosure therein. His own loss of weight being partly from the lungs and partly from the skin, the amount gained by the bag represented the quantity of the latter; the difference between this and the loss of his own weight gave the amount exhaled from the lungs.

He thus found that the largest quantity of *insensible* exhalation from the lungs and skin together amounted to three and a half ounces per hour, or five and a quarter pounds per day. The smallest quantity was one pound fourteen ounces, and the mean was three pounds eleven ounces. Three fourths of this was cutaneous.

These figures only show the quantity of insensible perspiration during repose. Valentin found that his hourly loss by cutaneous exhalation while sitting amounted to 32·8 grammes, or rather less than one and a quarter ounce. On taking exercise, with an empty stomach, in the sun, the hourly loss increased to 89·3 grammes, or nearly three times as much. After a meal followed by violent exercise, with the temperature of the air at 72° Fahr., it amounted to 132·7 grammes, or nearly four and a half times as much as during repose. A robust man, taking violent exercise in hot weather, may give off as much as five pounds in an hour.

The third excretion from the skin, the epithelial or superficial scales of the epidermis, is small in weight, but it is solid, and of similar composition to gelatine. It should be understood that this increases largely with exercise. The practice of sponging and "rubbing down" of athletes removes the excess; but I am not aware of any attempt that has been made to determine the quantity thus removed.

Does the skin excrete nitrogenous matter that may be, like urea, a product of the degradation or destruction of muscular tissue?

The following passage from Lehmann's "Physiological Chemistry," vol. ii, page 389, shows that the skin picks up plenty of nitrogen from somewhere: "It has been shown by the experiments of Milly, Jurine, Ingenhouss, Spallanzani, Abernethy, Barruel, and Collard di Martigny, that *gases*, and especially *carbonic acid* and *nitrogen*, are likewise exhaled with the liquid secretion of the sudoriparous glands. According to the last-named experimentalist, the ratio between these two gases is very variable; thus, in the gas developed after vegetable food, there is a preponderance of carbonic acid, and, after animal food, there is an excess of nitrogen. Abernethy found that on an average the collective gas contained rather more than two thirds of carbonic acid and rather less than one third of nitrogen." But it appears that less gas is exhaled when there is much liquid perspiration.

Lehmann's summary of the experiments of Abernethy, Brunner, and Valentin (vol. ii, page 391), gives the amount of hourly exudation, under ordinary circumstances, as 50·71 grammes of water, 0·25 of a gramme of carbon, and 0·92 of a gramme of nitrogen. This amounts to twenty-one and a half grammes of nitrogen per day in the *insensible* perspiration; three quarters of an ounce avoirdupois, or as much nitrogen as is contained in four and a half ounces of dried muscle, or more than one pound of natural living muscle.

That the liquid perspiration contains compounds of nitrogen, and just such compounds as would result from the degradation of nitrogenous tissue, is unquestionable. As Lehmann says (vol. ii, page 389), "the sweat very easily decomposes, and gives rise to the secondary formation of ammonia." Simon and Berzelius found salts of ammonia in the sweat; that the ammonia is combined both with hydrochloric acid and with organic acids; that it probably exists as carbonate of ammonia in alkaline sweat.

The existence of urea in sweat appears to be uncertain; some chemists assert its presence, others deny it. Favre and Schottin, for example, who have both studied the subject very carefully, are at direct variance. I suspect that both are right, as its presence or absence is variable, and appears to depend on the condition of the subject of the experiment.

Favre describes a special nitrogenous acid which he discovered in sweat, and names it *hydrotic* or *sudoric acid*. Its composition corresponds, according to his analysis, to the formula $C_{10}H_8NO_{12}$.

I have summarized these facts, as they show clearly enough that conclusions based on an examination of the quantity of nitrogen excreted by the kidneys alone (and such is the sole basis of the modern theories) are of little or no value in determining whether or not muscular work is accompanied with degradation of muscular tissue. The well-known fact that the total quantity of excretory work done by the skin increases with muscular work, while that from the kidneys rather diminishes, indicates in the plainest possible manner that an examina-

tion of the skin secretion should be primary in connection with this question.

Seeing that this has been entirely neglected, I am justified in expressing, very plainly and positively, my opinion of the worthlessness of all the modern research upon which the alleged refutation of Liebig's theory of the destruction and renewal of living tissue in the performance of vital work is based, and my rejection of the modern alternative hypothesis concerning the manner in which food supplies the material demanded for muscular and mental work.

I may be accused of rashness and presumption in thus standing almost, if not quite, alone in opposition to the overwhelming current of modern scientific progress. Such, however, is not the case. It is modern scientific *fashion*, rather than scientific *progress*, that I oppose. We have too much of this millinery spirit in the scientific world just now; too much eagerness to run after "the last thing out," and assume, with undue readiness, that the "latest researches" are, of course, the best—especially where fashionable physicians are concerned.

XLIX.—THE MODERN THEORY OF FOOD.

In my last I summarized Liebig's theory of the source of vital power, and its supposed refutation by modern experiments, but had not space to state the substituted theory. I will now endeavor to do so, though not without difficulty, nor with satisfactory result, seeing that the recent theorists are vague and self-contradictory. All agree that vital power or liberated force is obtained at the expense of some kind of chemical action of a destructive or oxidizing character, and is, therefore, theoretically analogous to the source of power in a steam-engine; but, when they come to the practical question of the demand for working fuel or food, they abandon this analogy.

Pavy says ("Treatise on Food and Dietetics," page 6): "In the liberation of actual force, a complete analogy may be traced between the animal system and a steam-engine. Both are media for the conversion of latent into actual force. In the animal system, combustible material is supplied under the form of the various kinds of food, and oxygen is taken in for the process of respiration. From the chemical energy due to the combination of these, force is liberated in an active state; and besides manifesting itself as heat, and in other ways peculiar to the animal system, is capable of performing mechanical work." In another place (page 59 of the same work), after describing Liebig's view, Dr. Pavy says: "The facts which have been already adduced (those described in my last paper) suffice to refute this doctrine. Indeed, it may be considered as abundantly proved that food does not require to become organized tissue before it can be rendered available for force-production." On page 81 he says: "While nitrogenous matter may be regarded as forming the essential basis of structures possessing active or living properties, *the non-nitrogenous princi-*

ples may be looked upon as supplying the source of power. The one may be spoken of as holding the position of the instrument of action, while the other supplies the motive power. Nitrogenous alimentary matter may, it is true, by oxidation, contribute to the generation of the moving force, but, as has been explained, in fulfilling this office there is evidence before us to show that it is split up into two distinct portions, one containing *the nitrogen which is eliminated as useless, and a residuary non-nitrogenous portion which is retained and utilized in force-production.*"

The italics are mine, for reasons presently to be explained. The following pages of Pavy's work contain repetitions and illustrations of this attribution of the origin of force to the non-nitrogenous elements of food.

Then we have a statement of the experiments of Joule on the mechanical equivalent of heat, connected with experiments of Frankland with the apparatus that is used for determining the calorific value of coal, etc., viz., a little tubular furnace charged with a mixture of the combustible to be tested, and chlorate of potash (better a mixture of chlorate and nitrate). This being placed in a tube, open below, and thrust under water, is fired, and gives out all its heat to the surrounding liquid, the rise of temperature of which measures the calorific value of the substance.

From this result is calculated the mechanical work obtainable from a given quantity of different food-materials. That from a gramme is given as follows :

Beef-fat	27,778	Units of work, or number of pounds lifted one foot.
Starch (arrow-root)	11,983	
Lump-sugar	10,254	
Grape-sugar	10,038	

In Dr. Edward Smith's treatise on "Food," the foot-pound equivalent of each kind of food is specifically stated in such a manner as to lead the student to conclude that this represents its actual working efficiency *as food.* Other modern writers represent it in like manner.

Here, then, comes the bearing of these theories on my subject. A practical dietary or *menu* is demanded, say, for navvies or for athletes in full work ; another for sedentary people doing little work of any kind.

According to the new theory, the best possible food for the first class is fat, butter being superior to lean beef in the proportion of 14,421 to 2,829 (Smith), beef-fat having nearly eight times the value of lean beef. Ten grains of rice give 7,454 foot-pounds of working power, while the same quantity of lean beef only 2,829 ; according to which one pound of rice should supply as much support to hard workers as two and one half pounds of beefsteak. None of the modern theorists dare to be consistent when dealing with such direct practical applications.

I might quote a multitude of other palpable inconsistencies of the theory, which is so slippery that it can not be firmly grasped. Thus, Dr. Pavy (page 403), immediately after describing bacon-fat as "the most efficient kind of force-producing material," and stating that "the *non-nitrogenous* alimentary principles appear to possess a higher dietetic value than the *nitrogenous*," tells us that "the performance of work may be looked upon as necessitating a proportionate supply of *nitrogenous* alimentary matter," his reason for this admission being that such nitrogenous material is required for the nutrition of the muscles themselves.

A pretty tissue of inconsistencies is thus supplied! Non-nitrogenous food is the best force-producer—it corresponds to the fuel of the steam-engine; the nitrogenous is necessary only to repair the machine. Nevertheless, when force-production is specially demanded, the food required is not the force-producer, but the special builder of muscles, the which muscles are not used up and renewed in doing the work.

It must be remembered that the whole of this modern theoretical fabric is built upon the experiments which are supposed to show that there is no more elimination of nitrogenous matter during hard work than during rest. Yet we are told that "the performance of work may be looked upon as necessitating a proportionate supply of nitrogenous alimentary matter," and that such material "is split up into two distinct portions, one containing the nitrogen, which is eliminated as useless." This thesis is proved by experiments showing (as asserted) that such elimination is not so proportioned.

In short, the modern theory presents us with the following pretty paradox: The consumption of nitrogenous food is proportionate to work done. The elimination of nitrogen is *not* proportionate to work done. The elimination of nitrogen is proportionate to the consumption of nitrogenous food.

I have tried hard to obtain a rational physiological view of the modern theory. When its advocates compare our food to the fuel of an engine, and maintain that its combustion *directly* supplies the moving power, what do they mean?

They can not suppose that the food is thus oxidized as food; yet such is implied. The work can not be done in the stomach, nor in the intestinal canal, nor in the mesenteric glands or their outlet, the thoracic duct. After leaving this, the food becomes organized living material, the blood being such. The question, therefore, as between the new theory and that of Liebig must be whether work is effected by *the combustion of the blood itself*, or the degradation of the working tissues, which are fed and renewed by the blood. Although this is so obviously the true physiological question, I have not found it thus stated.

Such being the case, the supposed analogy to the steam-engine breaks down altogether; in either case, the food is assimilated, is con-

verted into the living material of the animal itself before it does any work, and therefore it must be the wear and tear of the machine itself which supplies the working-power. and not that of the food as mere fuel-material shoveled directly into the animal furnace.

I therefore agree with Playfair, who says that the modern theory involves a "false analogy of the animal body to a steam-engine," and that "incessant transformation of the acting parts of the animal machine forms the condition for its action, while in the case of the steam-engine it is the transformation of fuel external to the machine which causes it to move." Pavy says that "Dr. Playfair, in these utterances, must be regarded as writing behind the time." He may be behind as regards the fashion, but I think he is in advance as regards the truth.

My readers, therefore, need not be ashamed of clinging to the old-fashioned belief that their own bodies are alive throughout, and perform all the operations of working, feeling, thinking, etc., by virtue of their own inherent, self-contained vitality, and that in doing this they consume their own substance, which has to be perpetually replaced by new material, the quality of which depends upon the manner of working, and the matter and manner of replacement. We may thus, according to our own daily conduct, be building up a better body and a better mind, or one that shall be worse than the fair promise of the original germ. The course of our own evolution depends upon ourselves, and primarily upon the knowledge of our own physical and moral constitution, and their relations to the external world. Of such knowledge even the humble element supplied by "The Chemistry of Cookery" is one that can not be safely neglected.—*Knowledge.*

INTERNAL ARRANGEMENT OF TOWN-HOUSES.

By ROBERT W. EDIS, F. S. A.

GOOD planning means not merely the arrangement of a certain number of rooms on a certain number of floors, but careful and close attention to the general domestic requirements and arrangements of the ordinary householder, and to all smaller details which make up the comfort and convenience of the house. It means that every foot of space shall be properly laid out, that there shall be no dark corners, and no inaccessible places, and that every room, closet, and staircase shall have ample light and ventilation, and that staircases shall be conveniently arranged, easy, with broad landings, and of sufficient width to allow of passing conveniently.

Each room has to be considered, and its relative proportion and position in the plan. The dining-room, or general eating-room of a house, should be so arranged that, although above the kitchen-level,

it shall not be at any unreasonable distance, whereby an extra amount of carriage of dishes and service is required.

If it be possible in an ordinary town-house of the first or second class, the dining-room should be placed at the back, as it is rarely used except at meal-times, and good outlook is not necessary; besides which, in summer-time, when it is pleasant to have windows open, if the room face a much-used thoroughfare, there is all the unpleasantness of noise of traffic and constant in-rush of dust; whereas, if placed at the back, provided always the light-area into which the room looks be of sufficient size, and lined with glazed bricks, with some slight variation in colored lines or panels, with window-boxes filled with sweet-smelling flowers or shrubs, there is freedom from noise and dust, and the comfort and quiet of the room are considerably enhanced.

Next the dining-room should, if possible, in every house, be arranged a small service-room, with a light service-lift from the basement, by which a considerable saving of labor will be gained, better service, and if, in this room, a small hot plate be fitted up, heated by gas, the plates can be brought in hot instead of half cold, as is so frequently the case. This lift should be taken down in the basement to a small china closet or pantry, close to the kitchen, but quite separate, so that it may not be made a funnel or shaft up which the smell of the kitchen can ascend. If, however, the kitchen be really properly ventilated, with plenty of fresh air inlets and extract-shaft over the fireplace—that is, immediately over the cooking portion of the kitchen—there should be no risk of smell, even if a serving-hatch is made direct into the kitchen; but it is better, if possible, to separate the two by a small lobby. If this special service-room can not be provided, a small lift may easily be arranged in the buffet, or at one end of the dining-room, and this need be only of the lightest description, so as to be easily workable by a maid-servant. To the lift, a speaking-tube or electric bell, or both, should be attached, and these will not only be found convenient at meal-times, but, in sudden emergencies, when unbidden and unexpected guests arrive and stay to dinner or luncheon, will give an easy means of communication between the mistress and the cook. It is well to get a service-room on the ground-floor, next to the dining-room, if possible, as this can be fitted up with sink and cupboards, all useful for washing up and storing away glass and china, and thus avoiding the risk of carrying up and down stairs. Naturally, the servant, man or woman, is anxious to save him or herself as many journeys from the basement as possible, and thus frequently he or she is inclined to overcrowd the trays, to the imminent risk of everything on them.

As a rule, a dining-room must have a central light over the table, but this should not be of such a size as to impede the view from either end, or to cause an amount of heat on the heads of those who are sitting round it. A small light, with a shade made to throw its rays

direct upon the table, with—if gas be used—side-brackets next the sideboard, and on either side of the mantel-piece, so as to distribute the light all over the room, and light up the pictures or whatever else is upon the walls, is infinitely better than a great blaze over the table, neither pleasant nor comfortable to those who have to face its glare, and ofttimes unpleasant heat. To avoid all this, it is essential that pure fresh air shall be introduced and distributed over the room, to take the place of that which necessarily becomes foul and tainted by fumes of cooked meats, gas, and the straining of the cubical contents of air-supply by a larger number than usual of people using the room. If there be no means of providing fresh air, and no means of extracting foul air, it follows that, in a very short time, the good air originally contained in the room will become tainted, and at last heated and foul.

Stand on a chair in an ordinary London room, about an hour after it has been lit up and the dinner commenced, and you will then obtain for yourselves some practical knowledge of the suffocating nature of the upper stratum of air, and will not wonder that faintness, nausea, and headache, are often necessary portions of a dinner-party in an improperly ventilated room.

All this can be cured by providing in, say, each corner a tube, adjusted in proportion to the size and height of the room, for the access of fresh air through gratings from the outside wall; and the current and amount of air injected, so to speak, into the room, can be easily adjusted by an ordinary butterfly valve, and all dust and soot, and other impurities kept back by a piece of fine silk or wet sponge. These tubes are often put in much too small, and the size of the outside grating is not considered; in all cases the size of the tube should be proportioned to the cubical contents of the rooms, and the external grating should be, practically, twice the area of that of the tube, as the iron-work of the grating, as a rule, diminishes its usefulness in ventilating area by about half.

If it be not possible to arrange for an extract shaft in the ceiling, a large-sized ventilator may be put in the flue over the fireplace, provided always it be fitted with talc flaps to prevent all back draught; but even the introduction of fresh air alone by some such means as those I have named will make a difference in a few minutes of many degrees in the temperature of the room.

In ordinary houses nothing has struck me as so wanting in thought as the general arrangement of the staircase. As a rule, you enter from the front door into a narrow passage-way, with perhaps an internal screen, with folding-doors which are rarely shut, and immediately opposite is the main staircase of the house, so that any one, on entering, not only commands the absolute thoroughfare of the house, but sees everybody who goes up or comes down, by which privacy is materially interfered with, and the whole house is made subject to sud-

den draughts of cold air, which are driven up the well-hole, as it is called, by the opening of the street-door.

There is no reason why the ordinary narrow entrance should not be increased two or three feet, so as to make a moderate-sized hall, in which you may have a fireplace, which will help to supply warm, fresh air all over the house, and, by a little care in planning, the first flight of stairs at least may be screened from view.

There are now very many good ventilating grates which can be so arranged as to provide, with communication from the outside, warmed fresh air, and if one of these, of sufficient size, be placed in the hall, it will not only help to ventilate it, and to lessen the evils of heated and foul air generated by the gaslight, but can be made the means of introducing warmed fresh air all over the house.

The staircase itself, whether it be of wood or stone, should never rise more than six and a half inches to each step, and, if possible, a landing or resting-place should be arranged every twelve or fifteen steps. In ordinary London houses the half-landing is sufficient, but all winders are fatal to a good staircase.

In the hall it is essential to have proper ventilation; if you shut the screen or inner hall doors, as a rule, the air becomes contaminated and heated by the gaslights, and the staircase and passages are fed with foul instead of fresh air. It is essential, therefore, that a proper supply of fresh air should be brought in independent of the door, and this can be done by means of a proper ventilating grate, or, if there is no fireplace, by a simple ventilating letter-box, or by some such arrangement as that which I have suggested for the dining-room; in fact, in every room throughout the house fresh air should be brought in, either warmed over hot-water coils, or direct through tubes communicating with the outside, or through some of the best of the now numerous ventilating grates, which are made so as to feed the house and counteract the evils caused by overcrowding, or by the products of combustion of gas or oil-lamps.

The library may be arranged as a comfortable and quiet apartment at the back, while the front space may be devoted to the morning or general reception-room, in which all the cheerfulness which the outlook into a London street allows can be obtained; but do not sacrifice the entrance and hall entirely to these rooms. Give an extra foot or two to the passage-way of the house, and you will not only make it more imposing and important, but will add materially to its comfort and convenience when you receive guests, and to its healthiness by providing a larger shaft for air circulation.

The basements of London houses are generally so badly arranged and ventilated that they add materially to their stuffiness; for, as a matter of course, all foul air is apt to fly upward, and if the basement be foul, heated, and unhealthy, it forms the practical reservoir from which the whole house derives a large amount of its general

temperature and tone, and too much care can not, therefore, be taken in its proper sanitary arrangement. Above all, in new houses it is important that the whole surface of the ground shall be covered with concrete, and that proper damp courses shall be inserted in the walls to keep down all damp, with air-bricks for ventilation under all wood floors. The basements should be, in every sense, dry and sweet, and all passage-floors made absolutely damp-proof, and the latter can best be done by putting down Portland cement concrete six or eight inches thick, finished off to a fair surface so as to form an even floor, and not, as is so often done, with a thin layer or covering of finer cement over the concrete bed, which, by-and-by, is sure to peel off and leave a rugged and uneven surface.

The scullery should, as a rule, form part of the kitchen, where the kitchen is not used for servants' meals and sitting-room, and not be shut off, or, if so, only by a low glass screen. It is merely a washing-up place, and should be under the immediate supervision of the cook, and not, as is so often the case, a small, dark, unpleasant, and ill-ventilated hole, in which bad smells are supposed to be allowed. It should be as fresh and as sweet as any other portion of the basement.

Line the whole of the scullery walls and, as far as possible, those of the kitchen also, with glazed tiles, so that there be no absorption and retention of the smells which must necessarily accrue with the ordinary work of this portion of the house; bring in fresh air, provide means for extraction of foul, but do not make a pestilential corner.

I can not too strongly advocate the finishing of all the walls in a basement, so far as the working portion of it, and the passages, are concerned, with glazed tiles; they are cleanly, absolutely non-absorbent, reflect and give light, are easily washed, and tend to make the house sweet and healthy. The pantries and larders should be so arranged that they have continued ingress of fresh air, and should in all cases be lined with glazed tiles or bricks, so that the emanations from the contents should not be absorbed in distempered walls.

They can easily be made fresh by bringing in outside air, by means of external gratings and tubes, and everything should be done to provide a constant draught and sweeping out of the foul air which is naturally engendered by hanging game and uncooked meat. The shelves should be of slate, or, better still, of polished marble, so as to be absolutely non-absorbent and easily cleaned.

As in all town-houses, where space is limited, a large portion of the rear offices derive their light and air from the small inclosed areas at the back, it is of the utmost importance that these areas should be lined with glazed bricks, to keep them as light and as sweet as possible, and, as the air at the bottom is likely to become stagnant and vitiated, a direct current should be insured up all these small light-areas, by means of a large induct shaft built under the basement floor

from the front area, so as to provide for constant circulation and change of air; this can be done at a very trifling cost, as the shaft may be formed of, say, glazed drain-pipes eighteen inches diameter, covered at each end with large open gratings made to lift up, so that the shaft may occasionally be cleared out.

In every basement a comfortable room for servants should be provided; some small sitting-room, fitted up with book-shelves and cupboards, and if possible facing the street, so that the workers of the house may have some sort of spare room in which they may be at rest from their ordinary duties; for if you want good servants you must treat them as ordinary beings like yourselves; and it is hardly fair to leave them for all hours in the heated and not always pleasant atmosphere of the working-rooms.

I can not too strongly insist upon the necessity of making those about us as comfortable as possible; for I am quite sure that, if we provide comfort and health for them, they will be much more capable of doing their daily work fairly and acting well by us. Remember always that a large proportion of their lives is spent absolutely underground, and that it is essential that they should have at least one room which shall be cheerful, well ventilated, and as pleasant as we can make it. Put yourselves in their places, and do as you would be done by, and, so far as my experience teaches me, I am morally certain that the master or mistress who provides well-lighted apartments for them to live and sleep in, will be more certain of keeping good servants, and of obtaining good work from them; if they are to be mewed up in ill-ventilated, uncomfortable, and unhealthy chambers for the greater part of their daily lives, you can hardly expect their work to be properly done; the atmosphere in which they live will enervate them, and make them comparatively useless.

The kitchen department should, as far as is consistent with proper and quick service, be shut off from the staircase of the basement, as this naturally acts as a funnel up which all smells ascend, so that, when the door at the top, which opens into the hall, is open, they escape and permeate the whole house; a swing-door can generally be arranged at the bottom of these stairs, provided with one of those patent American valve springs which close the door at once without allowing it to bang.

In every house, if possible, a small coal and luggage lift should be provided; in a new house, where there is a back staircase, it may run up in the well-hole; and in any old house it may often be arranged outside the back wall, with openings on to the various staircase landings.

If attention be paid to these smaller details in house-planning, I believe that in many cases the cost of a servant may be saved, for every one knows the daily labor in winter-time of carrying up heavy scuttles of coals and wood, and the great addition to the work of the

house by having constant journeys from the basement to the second and third floors.

Too much care can not possibly be taken in providing the necessary conveniences in the way of store-closets near to the kitchen, so as to reduce to a minimum the service and labor expenditure in the house; and in every case proper ventilation is easily obtainable by a little forethought on the part of the architect or builder, so that each closet and cupboard may be kept sweet and airy; there should be no dark corners in which dust and filth may be allowed to accumulate, but ample light and ventilation everywhere. It is easy to provide for a large fresh-air drain or channel from back to front, such as I have named, in every new house, out of which separate ducts may be taken to every cupboard or closet; and this main air shaft or duct should be continued into the back area, or lighting space for the back rooms, so that a constant draught shall be caused, and the air not allowed for a moment to stagnate.

The back areas are often of necessity made small, and if unprovided by some arrangement such as I have described, by which a constant change of air is enforced, the lower portion becomes absolutely foul and unwholesome, and any air drawn from it for ventilation is practically worse than useless.

In Professor Kerr's book on the planning of country-houses, he lays great stress on comfort as an essential element. Now, this means good constructive care in the arrangement of the different portions of the house; all proper and requisite conveniences, light, warmth, and good ventilation everywhere; freedom from damp and smells, no smoky chimneys, and no badly-constructed floors, through which noise from above or below may be readily heard. If these essentials are not properly looked after, the finest design, the most useful decoration, the most graceful art, all go for nothing, for common-sense people are apt to appreciate the mere material comfort and convenience of the house much more than the art-work in the external elevation, or in the internal decoration of their rooms.

I do not propose to enter upon the question of drains or sewage ventilation, as this subject has been treated by many more able lecturers than myself in these rooms, who have made it their special study, and I would only propose very briefly to refer to it. I can only insist upon every closet being thoroughly ventilated, upon all sink-wastes being cut off from the main sewer, and upon all drains which must perforce be carried through the house being laid and bedded in concrete, with man-holes at each end, to sweep them clean from end to end if necessary, for proper traps cutting off all drains directly from the main sewer; that all sink-wastes empty clear over proper traps, and to avoid everywhere any connection with the main drains, whereby sewer-gas can in any way be brought into the house.

All closets and bath-rooms should, if possible, be lined with tiles or

some equally non-absorbent material, for, unless this done, they soon become stuffy and unpleasant.

The drawing-rooms of the house should naturally be made as cheerful as possible, and doors arranged so as to allow for the proper circulation of your guests when the rooms are crowded.

The arrangement of windows and fireplaces should be carefully studied, so as to allow of sufficient wall-space for furniture, and in these rooms bay and recessed windows and cozy nooks will help to make them more liveable and comfortable, whether for the ordinary occupants, or on occasions when you receive your friends.

As a rule, I think two fireplaces are a mistake, unless the rooms be absolutely divided by doors or *portières*, as, when only one fire is alight, there is a tendency for it to act as a pump, and to draw down smoke through the other.

If the room be very long, a small coil of pipes, taken off the hot-water service, may generally be arranged under the back window, over which fresh air may enter for ventilation.

Street houses are more or less, by the limited nature of the ground on which they stand, bound to be very similar in plan; but they can all be materially improved by a careful study of the wants and requirements of the ordinary householder, and by a proper regard and attention to all the smaller conveniences which practically render the house comfortable or the reverse.

As a general rule, bedrooms are often very badly arranged; either the wall-space is planned so that the bed must be placed immediately opposite the light, or in a thorough draught between the door and fireplace. I am inclined to think that the modern system of arrangement in French bedrooms might with advantage be more frequently carried out in town-houses, and that the rooms might be made suitable for the double purpose of private sitting as well as bedrooms. In a house in which there are several grown-up sons and daughters, it will be evident that some such arrangement will commend itself, so that each may have a private working-room, for writing or studying, apart from the general living-rooms of the house. The bedroom may often, therefore, be divided up so as to form at one end—that farthest from the window—recesses for bed and washing-closet, which can be screened off in the daytime by a curtain, and the rest of the room fitted up as a sitting-room, wherein the occupant may receive his or her own more intimate friends if need be.

The dressing-rooms are often made much too small. They should be of sufficient size to hold a bed if requisite, so that it may be used on occasions when, let us say, the master of the house comes home late, and does not want to disturb the wife of his bosom in the small hours of the morning; or when sickness is in the house, the room can be used for a nurse; or if the master of the house be a professional man, afflicted occasionally with sleeplessness, he would often like to

take up his work, instead of tossing about for hours, or lying restless, and tortured with all the troubles which seemingly come in upon him on such occasions.

The nurseries of a house should be cheerful, well lighted, and well ventilated, and made to open into each other, so that at night-time the door may be left open, and the air space made as large as possible. A small pantry or scullery should be fitted up on the same floor, with sink and ample closets or cupboards for crockery and toys, and, if possible, a water-closet and bath-room close adjoining.

The servants' rooms should be made as healthy and convenient as any other rooms in the house, well lighted, and, being in part in the roof, care should be taken in all new houses to protect them from undue heat and cold by means of boarding and slates, by overlaying the former with battens, on which the slates are hung, so that, as far as practicable, the rooms may not be rendered hot and close in summer, or icy cold in winter. All these precautions can easily be taken in the building of a new house without any great additional cost, and will amply repay the extra outlay by the increased comfort and healthiness of the house.

Somewhere on the top floor a lumber-room should be provided, lighted from the roof, and this should be boarded all round, so as to prevent the damage which is often caused in plastered rooms by the boxes being placed roughly against the walls. A cistern-room is also essential in every well-found house, boarded in to keep it clean and free from dust and filth, which would be sure to foul the water; top-lighted, so as to enable the cisterns to be examined and frequently cleaned out, and from this room access might be had to the outside of the roof.

As far as practicable, all water-pipes, hot and cold, should be run up together, properly labeled and easy to be got at, in a chase or recess which should be cased over and closed with screws. The hot-water pipes, if properly felted in, would contain a sufficient amount of heat, long after the kitchen fire is out, to keep the space, even if next to an outside wall, well above freezing-point.

The bell-wires should all be laid in zinc tubing, the gas-pipes always iron, and not what is called composition, and in no case should any pipe of any kind be rendered inaccessible by being buried in some remote corner, or in the plaster-work of the rooms. The ordinary plumber and gas-fitter takes no heed of how his pipes go, and what happens to them after he has fixed them in their places; his anxiety seems to be to carry them by the shortest possible way to the points at which they are to be used, and, unless carefully looked after, you may be tolerably certain that they will be so hidden away that, in case of accident, you will have to pull up half the floors of your house, or knock about a good many of your walls, to discover any leakage, especially if it be in a gas-pipe.

Fire risk rarely enters the head of any builder, and he is content to leave the upper floors to be cut off by the burning of the wooden attic stairs, and allow the occupants to be slowly grilled or suffocated, that is, so far as any means of escape shall have been provided by him. In all high street houses ready access should be made at various points in the attic story to the roof, and iron ladders fixed against the party walls, so as to enable the occupants to get readily away. This has its objections, of course, as enabling thieves to pass from an empty house to any of those in the same block; but good trap-doors, well bolted and lined with iron, would practically keep them out, or at least they would make noise enough in their attempt to open them to make themselves heard when the house was occupied by the family.

Speaking-tubes should be put up in every house, or at all events one communicating on every floor, for it is quite easy to establish a simple code of signals by which one whistle calls the down-stairs servants, and two for those on the nursery-floors. In this manner the constant running up and down stairs to answer bells, and then to bring what is wanted perhaps up many flights of stairs, is avoided.

As Emerson says truly, in one of his essays: "Take off all the roofs from street to street, and we shall seldom find the temple of any higher god than prudence. The progress of domestic living has been in cleanliness, in ventilation, in health, in decorum, in countless means and acts of comfort, in the concentration of all the utilities of every clime in each house. . . . The houses of the rich are confectioners' shops, where we get sweetmeats and wine; the houses of the poor are imitations of these to the extent of their ability." Avoid all such imitations; let our houses be fitted for every-day wants, for every-day requirements; let them above all be clean, be comfortable, be healthy; let there be no unfound skeletons, no tangles that are not unraveled; open up the doors, let light and air in upon the skeletons, search them out; make the houses you live in pure from end to end, and depend upon it you will have less disease of mind or body, less worry, less enervation, unless you agree with the Scriptural statement that "Ahithophel set his house in order and hanged himself." One would have expected him to hang himself because his house was not set in order.

Remember always that the healthiness, the comfort, and the pleasant and artistic arrangement of your houses mean the healthiness, the education, and the bodily and mental soundness of your children.—*From a Lecture before the Society of Arts.*

SKETCH OF PROFESSOR JOHN TROWBRIDGE.

PROFESSOR TROWBRIDGE is the son of a physician, and was born in Boston in 1843. He prepared for Harvard University at the Boston Latin School, but did not join the Freshman class. He entered the Lawrence Scientific School, from which he was graduated in 1866. He was tutor in the Scientific School for the two years succeeding his graduation, and was appointed Assistant Professor of Physics in the Massachusetts Institute of Technology in 1868. In 1870 he was called to Harvard University as Assistant Professor of Physics to establish a laboratory course of instruction. He obtained the degree of Doctor of Science from Harvard in 1873. For the past six years he has been Professor of Experimental Physics in the university.

The descent and early education of scientific men have lately become the subject of investigation by Galton. None of the ancestors of Professor Trowbridge evinced any scientific tastes, although there were several who had strong literary tastes and also legal ability. Professor Trowbridge's father, believing in the adage of Bacon, that a boy, if given the range of a library, will select the food most suitable to his tastes, provided him liberally with books, but not with instructors; and, being fond of art himself, stimulated a certain fondness for drawing in the child. The consequence of this training was that, when the boy at the age of fourteen or fifteen entered the public schools, he had a large amount of desultory information in literature and a facility for drawing, but no systematic training in languages or in mathematics. While, however, many of his comrades who had been carefully trained in schools from an early age grew tired of intellectual effort, he came to the subjects of mathematics and the sciences with a certain freshness which might not have survived too much school-culture at an early age. His strong taste for art made his friends predict an artistic career as the only one suitable for him. His graduation at the Lawrence Scientific School with the degree of *Summa cum Laude*, and the evidence of strong mathematical tastes, determined his future career.

When Professor Trowbridge came to the university in 1870 as a teacher, the subject of physics was taught merely by lectures and recitations. He immediately secured a small room and fitted it up as a physical laboratory. From this small beginning arose, through his constant endeavor, the Jefferson Physical Laboratory, which is the largest laboratory of the kind at present in America. In order to secure this great means for advancing the study of physical science in the university, Professor Trowbridge has given his best efforts for the past ten years in the direction of personal solicitation, and by publishing in

various journals, and also in pamphlet form, papers upon the necessity of an adequate recognition of the importance of a well-equipped physical laboratory at Harvard University.

He was editor for two years of the "Annual of Scientific Discovery," published by Gould & Lincoln, of Boston—a publication which was a pioneer in the effort to make the results of science available to the general reader.

The first scientific paper of Professor Trowbridge was upon a new form of galvanometer, which he entitled the "Cosine Galvanometer." Before the invention of this instrument the tangent galvanometer and the sine galvanometer were the only forms of galvanometer known in scientific literature. The cosine galvanometer, which made use of the principle of a vertical coil, movable about a horizontal axis, gave an additional adaptation, and affords a convenient method of measuring strong electrical currents. His next paper was upon animal electricity. The result of long investigation had deepened in him the conviction that the observations of Du Bois-Reymond had not established the existence of so-called muscular electrical currents. The operation of detaching a muscle from its position and examining its electrical condition by means of a galvanometer must result in experimental errors which have hitherto masked any electrical currents due to the generation of electricity in the muscle itself. It is true that the torpedo and few electrical fishes can generate electricity; but in these animals certain organs for the generation of this electricity have been discovered, and this is not true of the ordinary muscle. The effects observed are due to the contact of the so-called non-polarizable electrodes with fresh muscular tissue; in other words, to the fact that the so-called muscular electrical currents had their seat in the contact between the electrodes and the fluids of the fresh muscle. These results, being in opposition to the belief of the leading German physiologists, were not accepted. Since the publication of Professor Trowbridge's paper, however, prominent German physiologists have taken the same view. He was one of the first to measure the relative efficiency of various forms of dynamo-electric machines. His experiments were conducted at the United States Torpedo-Station at Newport, Rhode Island. For this purpose he invented a new form of electrical dynamometer, which enabled one to measure the strongest electrical current without subdividing it.

In the course of this investigation, being struck with the large amount of heat developed by the reversals of magnetism in the core of an electro-magnet, he undertook a separate investigation together with the chemist of the Torpedo-Station, Mr. Walter N. Hill, upon the amount of this heating, in a great variety of steels of different composition, in the hope of arriving at a practical method of testing the composition of steel. The results of the investigation tend to strengthen the general belief that the heat due to the reversal of mag-

netism must be attributed to induced currents in the iron or steel, rather than to reversals of magnetism in molecular magnets. A later investigation upon the same subject tends to confirm the above result.

Among the instruments invented by Professor Trowbridge may be mentioned a new form of induction-coil, in which the primary coils are employed, and two induction-coils, the poles of the electro-magnets being connected by thin plates of iron. The spark produced from this combination by a mechanical break has great heating effect.

The active duties of a college professor leave little time for continued systematic investigation. A new era, however, is dawning in university education in America, and the college professor who shows ability for scientific investigation will undoubtedly be relieved of the yearly teaching of immature minds and be left free to devote himself to graduate students, to research, and to the general supervision of his department, rather than to the daily drill which should be left to trained assistants. Notwithstanding his full duties as a professor, Professor Trowbridge has published each year various investigations from the Physical Laboratory of Harvard University, which up to the present time has consisted of merely one room, inadequately fitted up for scientific work. In these investigations he has been often assisted by students. Among his researches are papers on the conveyance of heat by the electrical current in various metals, particularly in nickel; a paper written in association with Mr. C. B. Penrose, on the availability of a thermal junction for measuring very low temperatures; on the formation of vortex-rings in liquids, and an interpretation of the mathematical formulæ relating to vortex-rings in water; a paper by himself and Mr. Penrose, on the propagation of heat at right angles to, and in the direction of, the lines of magnetic force; a study of the effect of displacement of the compass in the Helmholtz's form of Gaugain galvanometer; a paper on the cause of the disturbances heard on telephone-lines, in which it was shown that a large part of their disturbances is due to the battery—earth. A survey of the country about Cambridge showed that the time-signals of the Harvard College Observatory were transmitted through the earth over a great extent of territory. This survey suggested to Professor Trowbridge the possibility of telegraphing across large bodies of water without a wire. Mr. Preece, of the London telegraphic system, acting upon the suggestion of Professor Trowbridge, succeeded in transmitting telegraphic signals from Southampton to the Isle of Wight, without a wire. Professor Trowbridge has also published various papers on thermo-electricity, a subject which has occupied his thoughts for many years.

The condition of the teaching of physics in the secondary schools having been brought to his attention by the want of preparation in this subject of students who present themselves for entrance to the university, Professor Trowbridge has prepared a treatise on experi-

mental physics, entitled "The New Physics," in which modern views of the great subject of physics are inculcated through the means of elementary laboratory work. He has also contributed various essays to the "Atlantic Monthly," one of which, entitled "The Dream of Life," is an argument, *ad hominem*, in favor of the option of scientific studies by students who desire to enter the university without Greek. His contributions to "The Popular Science Monthly" treat of various subjects, among which may be mentioned: "Science from the Pulpit"; "On the Teaching of Physics in the Secondary Schools"; "On the Use of Electric Lights for Steamships." In the latter paper, Professor Trowbridge advocated the use of the electric light for a head-light. Practical navigators, however, assert that such light is not to be recommended, for its dazzling glare confuses the eyes of the steersmen of approaching vessels.

His address before the American Association for the Advancement of Science was upon the question, "What is Electricity?" and, in reading it, one can discover the directions in which the author has investigated.* The life of an investigator is an arduous one; but few of the ideas which take months to investigate give what are called positive results. Faraday, it is true, gave to the world the history of both his successful experiments and his unsuccessful ones. It is not the custom, however, of later physicists to do this. Scientific literature is already voluminous, and this reticence of scientific men is perhaps a boon to those who desire to look up any subject. With the increased facilities which the new laboratory at Cambridge will give, Professor Trowbridge enters upon a fresh scientific career in the prime of life, and there is reason to hope that many positive results to science will accrue from his future labors.

He is a member of the American Academy of Arts and Sciences, of which he was secretary from 1879 to 1884; he is also a member of the National Academy of Sciences. He is one of the editors of the "American Journal of Science." He was a member of the International Congress of Electricians which met in Paris, in 1883, and of the United States Congress of Electricians which met in Philadelphia last October. He was also one of the Vice-Presidents of the American Association for the Advancement of Science for 1884, at the Philadelphia meeting.

* See "The Popular Science Monthly" for November, 1884.

CORRESPONDENCE.

CAUSES OF THE OHIO FLOODS.

Messrs. Editors:

IN the November issue of your valuable "Monthly" I have read with much pleasure and profit Mr. S. W. Powell's article entitled "Drowning the Torrent in Vegetation"; and, in closing, he writes, "In the recent Ohio floods the States which suffered most—Ohio, Indiana, and Illinois—were not those where most of the deforesting was done which caused the floods."

While I heartily agree with him that the removal of our forests adds largely to the destructiveness of the floods, yet I do not agree with him that to that cause can be attributed the greater portion of their destructiveness, and especially in Western Pennsylvania and Ohio, where the larger portion of the water came from that did the damage in Cincinnati and the Ohio Valley above.

My theory is, that the increasing destructiveness of the floods in the Ohio and Mississippi Valleys is mainly due to the rapid increase of tile-drainage throughout Pennsylvania and Ohio, and in small portions of West Virginia, and the entire country drained by the Ohio and Mississippi Rivers and their tributaries.

The facts are, that the increase of destructiveness of the floods in the Ohio Valley has been in a ratio corresponding with the increase of tile-drainage—as near as the statistics obtainable concerning the latter will show.

It is not the writer's purpose to discuss the matter at any length in this letter, but merely to call the attention of the reader to its probable truth or falsity.

It is a well-known fact that a goodly portion of the land lying between the Alleghany Mountains and a line drawn north and south through Dakota, Kansas, and Nebraska, and bounded on the south by West Virginia, Kentucky, and Arkansas, is more or less of a swampy nature, retaining the water as it falls—somewhat as a sponge would—and has, until very recently, been left in its natural state.

The rapid increase of population of the country has caused an increased demand for land, and, taken in connection with the improved machinery for making tile having reduced the price of tile to a mere nominal figure, has caused farmers to improve their damp and swamp lands, as well as much uplying land, by tile-drainage.

The effect of this has been to cause the water from melting snow and rain-storms to immediately discharge itself into the water-courses; whereas formerly from these swampy lands it ran off very slowly, and the same volume of water, that with tile-drains is discharged now in twenty-four to forty-eight hours, originally took from seventy-two to one hundred and twenty hours to discharge.

The best statistics obtainable show that tile-drainage has doubled since 1878, and will undoubtedly continue to increase very rapidly, because it has been found to prove advantageous to all lands, and I am informed that there is one farmer in this State who has, during the year 1884, laid upward of eleven miles of tile-drains upon his farms.

The writer predicts that but few years will pass before several of the lower streets of Cincinnati will be abandoned to the flood, and that many towns along the valleys will also be partially swept away and not rebuilt.

The only things which will prevent this will be slight rainfalls and very gradual thawing of the snow, whenever the latter falls to an extent to produce an amount of water that will cause a flood.

Farmers will not stop laying tile, because they have found it to be a paying investment, rendering swamp-lands tillable, and increasing the yield and sureness of crops upon the upland, as well as rendering it much more easy of cultivation. Consequently, it looks to us as though the dwellers in the "bottoms" must go.

Yours truly, JAMES F. SLATER.

HIGHLAND PARK, ILLINOIS, *November* 22, 1884.

DO ANIMALS FORETELL THE WEATHER?

Messrs. Editors:

IT may be of interest to state that our severe winter in this locality has been as unexpected and unprepared for by our small four-footed friends the musk-rats as by the human population. For many years our weather-wise people have based their predictions of severe or open winters on the manner in which the musk-rats built their houses. Last fall's indications were for a mild season, as the houses were exceptionally light and unsubstantial. Now the poor rats are suffering for their lack of foresight, and run about in the daytime, seemingly bewildered and dazed by the extreme cold, and fall easy victims to the small boys, who capture them with little trouble.

I have never been a believer in the superior knowledge of animals in foretelling weather, and this corroborates my ideas upon the subject. Respectfully,

E. C. MASON.

MADISON, WISCONSIN, *February* 19, 1885.

MEDICAL EXPERT TESTIMONY.

Messrs. Editors:

Referring to Dr. Hamilton's excellent article on "Medical Expert Testimony" in the March "Science Monthly," I am reminded of a very amusing incident reported in the "Daily Register" of this city a few months since. A negligence case was on trial in one of our courts. A physician was called as an expert, who testified that the plaintiff was suffering from the remote effects of an injury to the vaso-motor system of nerves, and would in time become insane. Being cross-examined with some severity, the doctor was asked, among other things, concerning his familiarity with Gross, "On the Recent and Remote Effects of Head-Injuries"; Lanery, "On Injuries of the Head"; Zehmayer, "On the Subsequent Effects of Nervous Shock"; and Carson, on "The Surgery of the Head," and he testified that he had read these books, and his library contained them all.

The opposing counsel called to the witness-stand a clerk from his office, who testified that the works above named were fictitious, and the titles were invented by him to expose the doctor's ignorance! In addition to Dr. Hamilton's very logical protest against the proposed appointment of a board of experts to be used on all occasions like a court crier or interpreter, I know of no more forcible protest than the above incident. These pedantic "experts" would be the only physicians who could afford to accept the position for its slender emolument, and men of Dr. Hamilton's caliber, who are the only men who ever *should* be called, would be wholly excluded! A. W. Gleason.

New York, *February* 20, 1885.

EDITOR'S TABLE.

PROGRESS AT HARVARD.

HARVARD UNIVERSITY is to be congratulated on its leadership in the important work of liberalizing the traditional college education. It has ended—or is on the way to ending—the narrow and intolerant policy of forcing upon all its students an old study not required by them, and the imperfect general acquisition of which has become a reproach to the institution, and the standing scandal of college education. Harvard has at last begun in earnest the work of putting Greek where it properly belongs, on the same basis as other studies. She has divested it of its arrogant claims, withdrawn the compulsion that has so long given it factitious consideration, and left it to be taken up and pursued like other subjects by those who value it. This is called waging war against the noble study of Greek; desecrating classical ideals, and destroying liberal education. It is quite the reverse. It is giving freedom to Greek; it is putting classics on their rightful foundation, and giving to education the liberality of greater liberty. But there is wailing in the classical camp. The newspapers are talking of the "fall of Greek," of "perilous experiments," of "momentous revolutions" and the sordid encroachments of the money-making spirit! And what has happened? Why, Harvard University has consented to accept of its candidates for admission a certain thorough and well-defined preparation in physics in place of the Greek formerly exacted. This is surely moderate, for they are not "fanatical iconoclasts" who have carried this reform to its present result in Harvard University. It is not true that this venerable institution has got on a useful-knowledge rampage and ordered all its dead-language books to be thrown into Boston Harbor. Those who desire to study Greek can still do so, but, by leaving it upon this basis, if there are fewer Greek students they are certain to be better ones. One would think that this consideration would weigh with the classicists, and that they would not distress themselves because their favorite study is to be elevated and yield more creditable results in the future. But, if they will be miserable over such a manifest step of improvement in dealing with their own subject,

we can not help it. Our ground of satisfaction is, that a formidable obstacle to the study of science has been got out of the way in an influential university, and that now it will be a good deal easier for other collegiate institutions to do the same thing.

THE SCYLLA AND CHARYBDIS OF ADMINISTRATION.

Mr. Frederic Harrison was perhaps not very far wrong when he spoke the other day of the position of comparative isolation which Mr. Spencer occupies, so far as his views on the proper sphere of government are concerned. There is probably no living philosopher, not the mere mouth-piece of a sect or school, whose general philosophical views command as wide assent as those of Mr. Spencer, but multitudes, who are willing to follow him when he discourses of evolution and of the relativity of knowledge, hold back when they are asked to accept the application which he makes of his general principles to practical questions of government. If, however, Mr. Spencer's philosophy rests on a sound foundation, as so many are prepared to admit, and if his views on the conditions of political and social well-being are legitimately deduced from the cardinal principles of that philosophy, then sooner or later the world must accept them or—suffer the consequences of rebellion against the teachings of right reason. Mr. Spencer can afford to wait for his vindication better, perhaps, than the world can afford to wait to adopt the plan of political salvation which he points out.

It may help to clear up the subject a little if we endeavor to show what the actual condition of things is, and what are the difficulties with which government, in the present unduly-comprehensive sense of the term, has to contend. We speak in the heading of this article of "the Scylla and Charybdis of administration." By Scylla we wish to signify the "spoils system," that under which the public offices are bartered for party services; by "Charybdis" we understand bureaucracy. Mr. Spencer says, "Steer away from both of these devouring monsters, by reducing the functions of government to a mere fraction of what they now are"; but the advice is not heeded. Our modern statesmen make straight for one or another of these sources of danger, or else try to steer between them—an experiment which generally results in damage from both sides.

The "spoils system" is too well known in this country to need much description. It consists essentially in making the hope of office, or of control in connection with the disposal of office, the mainspring of all political effort. What kind of political class this system tends to breed we know only too well. The type is the same, from the bar-room rowdy who trusts to his usefulness at election-times to secure him immunity from punishment when arraigned for assault or murder, up to the millionaire who buys himself a seat in the Senate. We see representatives of the system hanging round our city halls, waiting for their share of plunder, and meanwhile defiling rooms which ought to represent the decency and order of a great community with their rude and unsavory habits. We see them in the lobbyists and the pension agents, the men who advertise to procure situations for money, and all the other harpies that congregate at our national and State capitals. We see them in those members of Congress, not a few, whose whole idea of statesmanship is to watch, in the interest of their several localities, the progress of appropriation bills. We see them in influential journalists who make no effort to conceal the rage and scorn with which they are inspired by the very idea that office should be bestowed

otherwise than as a reward of political services. One of these, a year or so ago, bluntly expressed his innermost thought on the subject by saying that the effect of such civil-service reform as the Pendleton bill aimed at was to leave nothing for political ambition but—we must be pardoned if we quote the words exactly as given by the energetic editor—"a damned barren ideality." Another editor, not less energetic or able, sums up his objections to the present civil-service reform movement by calling it "pot-hook reform," holding it apparently beneath the dignity of a spoilsman to know anything about pot-hooks, or any other elements of a decent education. Enough that he should have known how to drum up a score of votes on election-day.

We see the results of the system, further, in the extreme inefficiency of legislation upon matters of national as opposed to matters of local consequence. An appropriation bill can always be put through. There are never wanting hands to roll that particular chariot along. Everybody seems to understand voting money. Everybody, with few exceptions, is ready to echo the cant phrases, the bogus formulas, about the importance of having the national Government represented in remote localities by costly public buildings, and extravagant mail services. Wherever a contract can be scented, it is easy to excite interest; but, when it is a simple matter affecting the national credit, the improvement of extradition treaties, the acquitting of a debt, the regulation of the consular service, the investigation of frauds on the republic, the case is very different; then it seems as if nobody could do anything, and matters are laid over from year to year. Anything more abortive or inane than a discussion on the tariff nobody could imagine. The advantage generally rests with the men who want high taxation, for the simple reason that they know what they want, and show an admirable consistency of purpose in laying burdens on the country at large for the benefit of themselves and their friends. The name this kind of thing goes by, strange to say, is not "plunder," but "protection." Until, however, those who believe in free trade have the courage to say so, the plunderers, who never lack for audacity, will have the best of it.

What the demands of the spoils system are upon the energies of cabinet ministers and others who ought to be attending to important duties, for which they are paid by the public, need hardly be dwelt upon. Those who have most experience in such matters will not contradict us if we say that three fourths of the time, and a larger proportion still of the energy of the heads of departments, are taken up, in one way or another, with questions of patronage, and that only the residue goes to considering how the public business can best be done. The office-seekers were a greater terror to Abraham Lincoln than the Southern armies, and, if the whole truth were known, it would be found that many a man has been hounded by them into his grave. Guiteau was but an extreme example of the audacity and shamelessness of the tribe. All the intermediate grades are kept full, and probably men are now known to the heads of the executive, not less impudent than Guiteau, though, happily, lacking his murderous fanaticism.

That relief should be sought from the terrors and horrors of the spoils system, in what is known as civil-service reform, is not surprising; and yet some of the arguments of those who oppose such reform are not without weight. They say that it is not desirable to form an official class; that it is not desirable to introduce into this country the stereotyped methods and the deadly routine of European officialism. They say that, where bureaucracy has thoroughly established itself, the office-

holder has great difficulty in realizing that the country was not created for him to govern and regulate; that he is a servant of the public is not in all his thoughts. Thay say that when men are virtually irremovable, save for gross misconduct, they generally become sluggish in the performance of their duties, and that in the higher officials this sluggishness becomes rank obstruction. They point to such an institution as the English post-office, which, during the *régime* of Rowland Hill, a man who was forced on it from without, exhibited a great degree of life and energy, but which, under his successors, shows the bureaucratic spirit in perfection, and is becoming as noted for its dullness and lethargy as once it was for intelligence and the spirit of progress. They say: Carry out the examination system consistently, apply it, as is done in England, to all branches and grades of the public service, and we shall in due time have here, not a flexible and self-adapting governmental machine such as we need, and as, to some extent, we have at present, but a vast and comprehensive mandarinism existing apart from, and (with the most benevolent purposes no doubt) presiding over our national life. They point to the intolerable airs which the official classes give themselves in most European countries—airs implying a definitely established superiority on the part of messieurs the functionaries over the citizens with whom they come into contact. They add that, however great an evil office-seeking may be to-day, it is after all confined to a small percentage of the people, those who, by reason of the political services rendered by themselves or their friends, conceive themselves entitled to some consideration in the distribution of patronage; whereas if commissioners and examiners are employed to perambulate the country, advertising the public service more or less in every city, town, and hamlet, the number of those whose minds will be more or less unsettled by the thought of perchance obtaining a government situation will be vastly greater. In such terrible colors is the Charybdis of bureaucracy painted by men who, for their own part, have no dread of the Scylla of the spoils system.

Well, the picture they draw is not very unlike the reality. We have as yet in this republic but a partial measure of so-called civil-service reform; but, if the time should ever come that the English system should be adopted in its entirety, there can be no question that, in the course of half a generation, we should have among us an official class such as we do not wish to see—men to whom the traditions and usages of their several departments would be of much greater moment and weight than the requirements of the public, or than the dictates of practical common sense. The public business would not be done on business principles, but on "departmental" principles—something very different. And, just as the governmental machine grew in size and complexity, would it more and more begin to constitute, in the eyes of those operating it, an end in itself. To master the technique, so to speak, of a department would take some years of application; and nothing would be easier than for the permanent officers to persuade political heads, who might wish to introduce reforms, that the machine was working as well as could be expected, and that to try and make it work otherwise than it was doing would throw everything into confusion. Of course, it would seem like great temerity on the part of a man of no experience to combat the views of a most respectable and apparently intelligent gentleman, who had perhaps grown gray in the performance of his departmental duties; and thus many an enterprise of pith and moment would turn its course awry, and lose the name of action, as the Prince of Denmark once thoughtfully observed. It would not,

however, be "the pale cast of thought" that would "sickly o'er" the good resolutions of reformers, but simply stall-fed obstruction that would crowd them aside. That things will come to such a pass in this country we are not prepared at present to predict. It is by no means certain that the "reform" principle will gain any more victories. There is much impatience at present of the difficulties it interposes in the distribution of patronage. We have, however, with our present ideas of the functions of government, just the two evils to choose between—the Scylla of the spoils system and the Charybdis of bureaucracy. Of course, we may try to combine the two, so as to have some experience of the evils of both; but the probability is, that sooner or later one or other will decisively carry the day.

Now, Mr. Spencer says: The whole trouble arises from your having so many offices to dispose of, and that comes of your having crowded so many functions upon the Government. You have brought on a condition of things dangerous to the peace and stability of the state. Had you left to private initiative and responsibility a very large part of what you now place on the shoulders of the Government, the office-seeking nuisance could never have grown to its present dimensions, nor could bureaucracy ever have been the incubus it now is on the life and energies of many communities. The time has come to unload, to repeal laws rather than to enact new ones. The organic growth of society is checked when you resort to what may, by comparison, be called the mechanical methods of legislation and governmental control. It is under the *régime* of freedom, not under that of compulsion, that social bonds are knit. If you would have virtue to grow strong, you must let it have its full value as virtue in the world; you must not try to equalize all varieties of character by repressive laws. If, however, you are determined to abandon organic methods, and to operate exclusively by means of the policeman's truncheon, more or less politely concealed, prepare yourselves for great convulsions, for the condition you will induce will not and can not be one of stable equilibrium.

The warning has been uttered. It remains to be seen whether it will be as the voice of one crying in the wilderness, or whether it will prove the signal for a new awakening of political intelligence, and the formation of a new and higher conception of the social state.

LITERARY NOTICES.

THE RISE OF INTELLECTUAL LIBERTY, FROM THALES TO COPERNICUS. By FREDERICK MAY HOLLAND, author of the "Reign of the Stoics." New York: Henry Holt & Co. Pp. 458. Price, $3.50.

THE author of this book has chosen a magnificent subject, and, although it is formidable in extent and much of it involved in obscurity, and all of it complicated with great questions of history and human progress, he has yet been able to throw much new light upon that liberalization of thought which went very unsteadily forward during twenty-two hundred years, before the great modern movement of the development for intellectual liberty. The work is a delineation of tendencies, a series of sketches of the great minds who at different times and under varied circumstances, and with unequal effect, have struck for independence of thought, a presentation of the counter-forces that have antagonized intellectual liberty, and an account of the working of all those larger agencies which have in different degrees hindered or promoted freedom and independence of thought. Without having subjected the work to critical scrutiny, we are much impressed by the evidence it shows of extensive and conscientious labor, the freshness and interest of its chief subject-matter, the untrammeled treatment of the subject, and the vigor of the portrayal of that long and agonizing conflict with bigotry and intolerance, religious and political, public and private, which is the price of our modern liberty of thinking.

It is a noteworthy fact that the work has not been executed under the bias of any preconceived theory. The author says: "I did not start with the intention of proving anything; and it was only when I was ready to write the last chapter that I found myself justified in drawing the conclusions set forth." This state of mind is undoubtedly favorable to impartiality of statement, and can hardly fail to inspire the reader with a considerable measure of confidence in the trustworthiness of the author's representations.

The author indicates the manner of execution of his volume in the remark: "I have tried to collect the important facts, especially such as had not been stated in English, to arrange them in their historic relations not yet fully delineated in any language, and then to let them tell their own story without needless comment."

SECOND ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY TO THE SECRETARY OF THE SMITHSONIAN INSTITUTION, 1880–'81. By J. W. POWELL, Director. Washington: Government Printing-Office. Pp. 514.

THE researches of this bureau are bringing to light an abundance of information in regard to the arts, institutions, languages, and opinions of the American Indians.

Mr. Frank H. Cushing's work especially has attracted wide attention, though the accounts as yet published cover only a small part of his observations. He contributes to this volume a paper on "Zuñi Fetiches." The Zuñi worships in general the mysterious powers of Nature, and especially the beasts, which he regards as most nearly related to himself, and hence in position to mediate between him and the more remote powers. He believes that the hearts of the beasts of prey have the power to take away the strength of the game-animals, thus making them easy to capture. Without recourse to the proper fetiches, so as to obtain the aid of this influence, the Zuñi deems it useless to attempt the chase of game-animals. The favorite fetiches are mineral concretions, or eroded pebbles having some resemblance to the forms of animals, which is usually heightened artificially. The priests assert that these are the actual bodies, petrified and shrunken, of the animals which they resemble, and that their hearts still live in the fetiches, although their bodies are turned to stone. A flint arrow-head is usually bound to the back or side of the figure, and strings of beads are sometimes hung around it. The fetiches of the beasts of prey are the most esteemed, and the name of this class, *Wē-ma-we*, is used for all fetiches.

Mrs. Erminnie A. Smith has embodied in a paper a large number of Iroquoian traditions relating to mythical gods and other supernatural beings, the practice of sorcery, and the origins of various phenomena, together with descriptions of religious festivals, and miscellaneous tales of adventure. Echo was the Mars of the Iroquois. In their wars with other tribes, by repeating among the hills their cries of "*Go-weh!*" he secured for them almost certain victory. The Thunder-god has been regarded as a special protector of this people. Among the supernatural beings were the Stone Giants, mortal enemies of men; the Pygmies, a friendly race; and the Great Heads, which were borne by their long hair, as by wings, on missions of mercy or of destruction. The aim of the essay on "Animal Carvings from Mounds in the Mississippi Valley," by Henry W. Henshaw, is to show that, of these carvings which can be identified, none represent animals which are not indigenous to the Mississippi Valley, and that the art-culture of the mound-builders has been greatly overestimated. Dr. Washington Matthews, U. S. A., describes briefly the tools and processes with which Navajo silversmiths produce a variety of quite elaborate articles. "Art in Shell of the Ancient Americans" is treated at considerable length by William H. Holmes. Fifty-seven plates accompany the paper, showing forms and patterns of dishes, implements, beads, wampum-belts, engraved gorgets, etc. Many extracts from early writers are given, describing the use of wampum-belts as ornaments, currency, and as tokens of treaties. Two catalogues of articles obtained from Zuñi and other Pueblos of New Mexico and Arizona, by James Stephenson, occupy the last 150 pages of the volume. These collections contain 3,905 specimens, consisting largely of pottery, but including basketry, implements, clothing, images, etc. The decoration of much of the pottery, as shown

by the figures, is elaborate and often graceful. The whole volume, especially these catalogues, is lavishly illustrated, containing 154 full-page plates, many of them colored, besides thirty-five figures in the text.

SIXTH ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF ILLINOIS, JOHN H. RAUCH, M. D., Secretary. Pp. 324.

AMONG the peculiar functions of this board, with the operation of which the present report largely deals, is that of the execution of the act to regulate the practice of medicine in the State. The medical profession is thus brought within the scope of sanitary laws, and under responsibility to a body with power. It is the duty of the board to issue certificates authorizing practice in the State to "all who furnish satisfactory proof of having received diplomas or licenses from legally chartered medical institutions in good standing." It became necessary to determine what was "good standing," and what institutions came under it. To define the term, the consensus of leading members of the profession and the faculties of medical colleges, in answer to letters soliciting their opinions, was taken. Then test questions were sent out to the colleges, the answers to which determined whether they came up to the standard. In evidence of the improvement in the standards of medical education, it is stated that, whereas in 1880 fourteen medical schools in the United States required of candidates for admission evidences of preliminary education, ninety schools now require them; eighty schools give instruction in hygiene, to seventeen in 1880; and twenty-three make attendance on three or more courses of lectures a condition of graduation, to eight in 1880, while fifty-six others are making tentative efforts toward the same point. The board is issuing a series of "Preventible Disease Publications," to which have been added during the year circulars on the prevention and control of scarlet fever and of diphtheria, and upon the sanitary features of typhoid fever and the prevention of its spread. These publications are in demand, and are often reprinted in the newspapers. Some of them have also been issued in German and in the Scandinavian languages. Nearly half the volume of the report is occupied with the lists of licensed physicians and midwives.

NOTES ON THE OPIUM-HABIT. By ASA P. MEYLERT, M. D. Third edition. New York: G. P. Putnam's Sons. Pp. 47.

THE purpose of this publication is to make a plea for more humane methods of treating the opium-habit than have heretofore prevailed. The author believes that no disease known to man demands such varied treatment as this of opium. "The habit was formed to relieve a single symptom of diverse disorders, namely, pain. . . . The original disease often remains in abeyance, ready to break forth when the drug is discontinued, and, if this disease be not cured, the habit is not cured." Again, the habit itself provokes disease, and this must be treated variously. There is, therefore, no specific for the opium-habit. There is, likewise, no quick cure for it. The present edition of the book has been thoroughly revised and largely rewritten. Since the first publication of the "Notes" the author has found the opium-habit more widely prevalent than was first surmised.

COMPARATIVE PHYSIOLOGY AND PSYCHOLOGY. By S. V. CLEVENGER, M. D. Chicago: Jansen, McClurg & Co. Pp. 258. Price, $2.

THE secondary title of this book characterizes it as "a discussion of the evolution and relations of the mind and body of men and animals." Its intention is to elaborate, as far as possible, a practical mental science which will reconcile the observations of anatomists, psychologists, and pathologists, with direct reference to the more intelligent treatment of insanity. Insanity, the author believes, will be better understood, and its treatment will become more scientific in proportion to the development of psychology, based upon comparative microscopic anatomy, and a physiology into which molecular physics shall enter more in the future. The system under which the metaphysicians have studied mental workings is regarded as having been so insufficient and one-sided, and their deductions often so absurd, as to discourage honest investigators and throw discredit on the pursuit. But a more sensible psychology has been evolved under the influence of such thinkers as Herbert

Spencer and Darwin, and of the investigators who have worked in their spirit. The author proposes to apply an extension of Mr. Spencer's principles to the study, and starts out with the proposition that mental phenomena are modes of chemical energy.

ANNUAL REPORT OF THE CHIEF SIGNAL-OFFICER TO THE SECRETARY OF WAR FOR THE YEAR 1883. Washington: Government Printing-Office. Pp. 1,164, with Forty-eight Plates.

THIRTY enlisted men were instructed in signal-service duties at Fort Myer. Efforts were made to add to the number of officers who can be depended upon for weather-predictions. The stimulus which the work of the bureau has given to the study of meteorology is noticed with gratification. The preparation of a text-book containing an elementary course of meteorology has been begun, and a new treatise from a philosophical, mechanical, and deductive point of view is in hand. From 84·4 to 88·3 per cent of the "indications" published during the previous ten years to 1883 were verified, and from 75 to 83·9 per cent of the cautionary signals displayed since 1874. The scientific work of the bureau was pursued in applications too numerous to be named specifically here. The number of stations had to be decreased on account of insufficiency of appropriations; but 376 were in operation in June, 1883, and work for the service was done by 19 officers and 500 enlisted men. Reports were received from 335 foreign stations, 59 steamship lines, 605 vessels, and 339 voluntary observers. The publications of the service include the "Monthly Weather Review," the "Monthly Summary and Review," the "International Bulletin," the "Meteorological Record," and several special papers.

OSTEOLOGY OF NUMENIUS LONGIROSTRIS. By R. W. SHUFELDT, U. S. A. Pp. 32, with Plates.

NUMENIUS LONGIROSTRIS is the long-billed curlew, which Captain Shufeldt observed alive at Egmont Cay, Florida, and studied anatomically in Wyoming. Besides minute descriptions of this bird, his monograph includes notes upon the skeletons of other American *Limicolæ*.

THE ASIATIC CHOLERA, as it appeared at Suspension Bridge in July, 1854, and its Lessons. By FRANK H. HAMILTON, M. D. Pp. 26.

THE outbreak described was sudden, violent, and narrowly limited in its spread to ground of a peculiar physical condition. The disease appears to have been introduced by a company of German immigrants, who were "dumped" upon the banks of the river from the cars, and was propagated with wonderful speed among the people, mostly employed on the suspension-bridge, living in the favorable locality. Dr. Hamilton's conclusions appear to agree, generally, with the view of Dr. Pettenkofer, that, while the implanting of a germ may be essential to the inception of cholera, the violence of the attack and the rapidity of propagation are largely dependent on soil-conditions.

COMPARATIVE STUDY OF THE NEW HIGH GERMAN LANGUAGE, THEORETICAL AND PRACTICAL. By WILLIAM W. VALENTINE. Richmond, Va. Seventy specimen pages.

PROFESSOR VALENTINE believes that the modern languages, especially German, are as capable of philosophical study as any of the ancient tongues which have been avowedly treated in that manner, and whose capacity for such treatment has been extolled, and that such study of them is most valuable as a means of intellectual training. The present pamphlet is intended to present an outline or suggestions, indicating the principles on which the study should be based, and the manner in which it can be pursued, and is offered tentatively in anticipation, provided the plan finds favor, of the preparation of a full treatise.

DESCRIPTION OF CARCHARODON CARCHARIAS. By W. G. STEVENSON, M. D. Poughkeepsie, N. Y. Pp. 8, with Plate.

THE various descriptions given of this fish, which is otherwise known as the "man-eater shark," are so very imperfect and confusing that the author says, with Professor D. S. Jordan, that "there is no good description of the animal extant." A shark of this species was taken in August, 1883, near Nantucket, and specially examined by Dr. Stevenson. The present monograph is the fruit of this study.

BLACK AND WHITE: LAND, LABOR, AND POLITICS IN THE SOUTH. By T. THOMAS FORTUNE, Editor of "The New York Globe." New York: Fords, Howard & Hulbert. Pp. 310. Price, $1.

THE author is a thinking man, and a molder of opinion among the colored people. He views the situation in the South, as the war and reconstruction have left it, and the present finds it, from the point of sympathy with his race; yet, with the mental breadth of a man educated in public affairs, he is able to discern that there are other sides to the question. He urges national compulsory education as a means of mitigating the dangers threatened by the existing situation; but the main purpose of his book is to show that the social problems in the South are, in the main, the same as those which afflict every other civilized country; that the future conflict in that section will not be racial or political, but between capital and labor; that poverty and misfortune make no invidious distinctions of race, color, or previous condition, but that wealth unduly centralized afflicts all alike; and that some unity of organization and action should be secured between the labor elements of the whole United States.

DEGENERATION THE LAW OF DISEASE. By L. A. MERRIAM, M. D Omaha, Neb. Pp. 8.

THIS is the substance of a paper read before the Medical Society of Omaha in September last, the import of which is to apply the theory of evolution to the study of disease. It regards disease as consisting in a reversed evolution, or degenerative changes; as induced by processes of degeneration of the tissues and functions, and in turn inducing such processes.

PROTECTION AND COMMUNISM. "Questions of the Day," No. 15. By WILLIAM RATHBONE. New York: G. P. Putnam's Sons. Pp. 42. Price, paper, 25 cents.

THIS pamphlet aims to show that the protective tariff has caused the sudden alternations between hard times and good times in the United States, has caused communism to increase in this country, while it has been decreasing in England, and has made our rich men richer and our poor poorer. The writer believes that, if the United States had not adopted protection twenty years ago, they would lead England in commercial prosperity to-day, and could gain the same position with free trade in another twenty years.

OTTAWA FIELD-NATURALISTS' CLUB. "TRANSACTIONS," No. 5. 1883–'84. Ottawa, Canada: Citizen Printing and Publishing Company. Pp. 152.

THE club has been active during the year covered by this number of its "Transactions." During the summer, it made four regular excursions, and numerous minor excursions were made by its branches; in the winter, seven *soirées* were held, at which papers were read and reports presented. The membership has increased from 108 to 128. The "Transactions" contains the inaugural address of the president, H. B. Small, with papers describing observations made in the immediate vicinity, to which the work of the club is confined, and reports of the six branches into which the club is divided.

THE SUN. Vol. I, No. I, January and February, 1885. Kansas City, Mo.: C. T. Fowler. Pp. 28. Price, 20 cents, or $1 per annum.

"THE SUN" is a bi-monthly paper devoted to co-operation. The present number has a portrait of Herbert Spencer, and discusses as its special subject, "Co-operation; its Laws and Principles," which is considered under twenty-five sub-heads. The next number will be devoted to "The Reorganization of Business" on a labor instead of a usury basis.

JOURNAL OF THE NEW YORK MICROSCOPICAL SOCIETY. Edited by BENJAMIN BRAMAN. Vol. I, No. I, January, 1885. New York: 12 College Place. Pp. 32. Price, $1 a year (nine numbers).

THE title indicates the object, and to some extent the character of the publication. The present number contains the proceedings of the society named, for October, November, and December last; a paper on "Electrical Illumination in Microscopy," by E. A. Schultze; discussions bearing on pollen-tubes; "Miscellanea"; and an index to articles in various publications of interest to microscopists.

ORIGINAL RESEARCHES IN MINERALOGY AND CHEMISTRY. By J. LAWRENCE SMITH, Membre Correspondant de l'Institut de France (Académie des Sciences), etc. Printed for presentation only. Edited by J. B. Marvin, B. S., M. D. Pp. 630. Louisville, Ky.: John P. Morton & Co.

THE title of this work indicates the chief line of research pursued by the author of its papers in his long and active career as an original scientific inquirer. We printed in the "Monthly" for December, 1874, an interesting sketch of his busy life, and an account of his more important investigations. He issued a volume of "Scientific Researches" in 1873, which contained the most valuable of his contributions up to that date. The present volume is a reprint with but very little editorial change of his principal papers published since that time. It is a valuable record of recent results in mineralogical chemistry; and especially with reference to meteorites, which was a prominent subject of study with Dr. Smith.

POEMS OF SIDNEY LANIER. New York: Charles Scribner's Sons. Pp. 246. Price, $2.50.

FROM "The Independent," "Scribner's," "Lippincott's," "Appletons'," and other magazines, these occasional poems have been collected by the widow of the poet. Most of them are characterized by a tender sadness, as might be expected from a writer who had known more pain than joy. "The Symphony" and "Psalm of the West" are of a more vigorous type, and a humorous vein appears in several dialect poems. The poems are preceded by a memorial sketch by William H. Ward, who rates Sidney Lanier as "much more than a clever artisan in rhyme and meter."

MAN IN THE TERTIARIES. By EDWARD S. MORSE. Salem, Mass.: The Salem Press. Pp. 15.

THIS is the vice-presidential address delivered before the Anthropological Section of the American Association, over which the author presided at the last meeting of the Association in Philadelphia. It reviews the evidence in favor of the high antiquity of man on the earth. An abstract of the address was published in "The Popular Science Monthly" for December.

THE AGRICULTURAL GRASSES OF THE UNITED STATES. By Dr. GEORGE VASEY. THE CHEMICAL COMPOSITION OF AMERICAN GRASSES. By CLIFFORD RICHARDSON. Washington: Government Printing-Office. Pp. 144.

THIS report is a contribution toward answering the question whether we can not select, from our wild or native species of grass, such as may be cultivated in those parts of the country unprovided with suitable kinds. The native grasses of the Territories receive most attention, and some information concerning the herbage-crops in the Gulf States is given. A large number of grasses are described, and one hundred and twenty varieties are figured in full-page plates.

UNITED STATES PUBLICATIONS: MONTHLY CATALOGUE. Vol. I, No. I, January, 1885. Washington, D. C.: J. H. Hickox. Pp. 22. Price, $2 per annum.

THE Catalogue will include the titles of publications of every description printed by order of Congress, or of any of the departments of Government, during the month preceding the date of its issue.

THE STORY HOUR. For Children and Youth. By SUSAN H. WIXON. New York: Truth-Seeker Company. Pp. 222.

A COLLECTION of articles, with elegant illustrations, from the youth's department of the New York "Truth-Seeker." It has been the author's aim to produce a book "that, while pleasing, will awaken healthy thought, and stimulate to right endeavor." It is claimed to be "pure in tone, entirely free from superstitious taint, and well calculated to broaden, brighten, and strengthen the growing mind."

PROCEEDINGS OF THE AMERICAN SOCIETY OF MICROSCOPISTS. Seventh Annual Meeting, Rochester, N. Y., August, 1884. Buffalo: Bigelow Brothers. Pp. 300.

SEVERAL of the papers of the "Proceedings" are given in full, among them an account, by Dr. George E. Fell, of the discovery by the aid of the microscope of an interpolation in a written contract. The opening address of President Jacob D. Cox reviews a part of the work of Robert B. Tolles in the improvement of the microscope, and is followed by a memoir of Mr. Tolles, by George E. Blackham.

GEONOMY: CREATION OF THE CONTINENTS BY THE OCEAN-CURRENTS. By J. STANLEY GRIMES. Philadelphia: J. B. Lippincott & Co. Pp. 116.

THE author of this book is introduced by the Rev. W. R. Coovert as a writer who published a book to advocate theistic evolution—"a volume which was more Darwinian than Darwin himself, excepting that it was decidedly and avowedly theistic"—eight years before the "Origin of Species" was issued. He has also published a work bearing on spiritism and mesmerism. The purpose of the present volume is to expound a theory that all the elevations of the earth's crust have resulted from the sinking of the ocean-basins, or of smaller local basins, beneath the weight of the sediment; that this sediment was collected by elliptical currents working in the waters, of which three pairs are supposed, causing three pairs of sinking basins, corresponding with the North and South Atlantic, the Pacific, and the Indian Ocean basins; that the fluid or plastic lava forced from beneath the sinking basins was driven under the crust in the interoceanic spaces, and, raising them up, created three pairs of continents. The configuration and relative situations of the continents and ocean-basins, etc., are accounted for in other propositions.

SUNLIGHT. By the author of "The Beginnings," "The Biography of Dust," etc. Pp. 70.

A SERIES of letters, by Mr. N. P. Malet, first published in "The Northern Whig," of Belfast, Ireland, in elucidation of a theory that light, not heat, is the primary and potent force, separate from heat. From his premises the author deduces that the heat attributed to the sun is in reality generated by the action of the sun's light on the gases of the earth. Extending his theory to a general cosmogony, he holds that the natural beginnings of this earth and the other planets and asteroids were separate, nebulous gaseous masses gravitating in space, till they were in turn sensible to the light of the sun, and became the worlds of this solar system. Vegetation is accounted for by supposing that the seeds of the first plants were brought to the earth by vapors or gases from other worlds.

AN ACCOUNT OF THE PROGRESS OF CHEMISTRY IN THE YEAR 1883. By Professor H. CARRINGTON BOLTON. Washington: Government Printing-Office. Pp. 32.

THE "Account" has been prepared for the Smithsonian Report for 1883, and is here given in separate form. It records the more important discoveries in chemistry, and the new processes and applications brought to light during 1883, arranged under the heads of "General and Physical," "Inorganic," and "Organic," a chemical bibliography of the year, and notices of chemists who died during the year.

RURAL SCHOOLS; PROGRESS IN THE PAST; MEANS OF IMPROVEMENT IN THE FUTURE. Washington: U. S. Bureau of Education. Pp. 90.

THIS is Number 6 of the "Circulars of Information" of the Bureau of Education for 1884. It was prepared by Miss Annie T. Smith, under the direction of the Commissioner of Education, to collate the information accessible on the subject. It embraces a review of the present condition of ungraded schools; comparisons of the courses of study and the daily programme for the distribution of time and subjects in schools of Michigan, Virginia, and Wisconsin, with those employed in France, Switzerland, Prussia, and Austria; papers on "Pedagogic Principles," and suggestions on special points in teaching.

THE COMPOSITION AND METHODS OF ANALYSIS OF HUMAN MILK. By Professor ALBERT R. LEEDS, Ph. D. Pp. 24, with Plates.

PROFESSOR LEEDS here compiles the analysis of eighty specimens of human milk. Considerable variety is exhibited in the results. Many of the samples appear to contain a body hitherto unknown, and not yet isolated or determined, which gives in the ethereal extract of the copper albuminate an emerald-green solution. While the superficial physical characteristics of the mother are not shown to be related to differences in the composition of the milk, an intimate connection appears with actual physical conditions. The samples obtained from women of over-robust habit were not so rich in albuminoids as those from pronounced anæmic women. Generally speaking, the best milk was obtained from lean women in good physical condition.

"THE JOURNAL OF MYCOLOGY," Vol. I, No. 1, January, 1885. W. A. Kellerman, Ph. D., J. B. Ellis, and B. M. Everhart, editors. Manhattan, Kansas. Monthly. Pp. 16. Price, $1 a year; single numbers 15 cents.

THE "Journal" is devoted exclusively to mycological botany, and, while giving special attention to descriptions of North American species of fungi, will publish accounts of the current literature pertaining to the subject. The present number contains original descriptions of twelve new fungi from Kansas and fifteen from Iowa, with notices of "North American Geasters," and of other fungi of Kansas.

NOTES ON THE PROGRESS OF MINERALOGY IN 1884. By H. CARVILL LEWIS. Philadelphia:

PROFESSOR LEWIS is in the habit of preparing, as chief in that editorial department, monthly summaries for "The American Naturalist," of the discoveries and new ideas in mineralogy. The present pamphlet is the collection of all of these summaries that appeared during 1884, and presumably includes all that occurred worthy of special notice, in mineralogical research, during the year.

MIND IN MEDICINE. By Rev. CYRUS A. BARTOL, D. D. New York: M. M. Holbrook. Pp. 39. Price, 25 cents.

THIS pamphlet embodies the substance of two sermons preached by the author on successive Sundays extolling the value of a sound mind as an element of health, and the virtue of mental remedies for disease. "Bodily strength, fresh color in the cheeks, more alert steps, and cheerier tones," says he, "are revelations of mind shining through the body. . . . You sail for Porto Rique! Well, a person not airy, but atmospheric, may be a warmer climate, relieving your ailments better than that island, or Mentone, Pau, or St. Augustine."

"BABYHOOD," December, 1884. LEROY M. YALE, M. D., and MARION HARLAND, Editors. 18 Spruce Street, New York. Pp. 32. Price, 15 cents a number; $1.50 a year.

"BABYHOOD" is devoted exclusively to the care of infants and young children, and the general interests of the nursery. Its purpose is to become a medium for the dissemination of the best thought of the time on all subjects connected with the needs of the child, embracing in its scope the period from the day of birth to the age when the nursery is supplanted by the school-room. There is certainly a place for such a magazine.

PUBLICATIONS RECEIVED.

Sex in Mind and in Education. By Henry Maudsley, M. D. Syracuse, N. Y.: C. W. Bardeen. Pp. 36. 15 cents.

Calisthenics and Disciplinary Exercises. By E. V. De Graff. Syracuse, N. Y.: C. W. Bardeen. Pp. 39.

University of Nebraska. Seventh Biennial Report of the Board of Regents. Pp. 32. The Chancellor's Report. Pp. 75. Lincoln, Neb.

State Inspector of Oils, Minnesota. Special Report on Illuminating Quality. By Henry A. Castle, State Inspector. St. Paul. Pp. 24.

Building for the Children in the South. By Rev. A. D. Mayo. Washington: Government Printing-Office. Pp. 16.

Cremation scientifically and religiously considered. By Henry Houston Bonnell. Philadelphia: D. C. Chalfant. Pp. 13.

Bulletin of the Washburn College Laboratory of Natural History. Edited by Francis W. Cragin. Vol. I, No. 2. Topeka, Kansas. Pp. 84, with Two Plates. 20 cents.

An Account of the Progress of Anthropology in the Year 1883. By Professor Otis T. Mason. Washington: Government Printing-Office. Pp. 43. Anthropological Notes in the "American Naturalist." By Professor Otis T. Mason.

Commissioners for the Erection of the Public Buildings, Philadelphia. Report for 1884. Pp. 32.

Supplemental Report of the Railroad Commission, Tennessee. John E. Savage, Chairman. Nashville: A. B. Tavel. Pp. 31.

"The Medical Analectic." Monthly. Walter S. Wells, M. D., Editor. January, 1885. New York: G. P. Putnam's Sons. Pp. 48. $2.50 a year.

Illinois State Board of Health. Report of Proceedings. Springfield, Ill. Pp. 19.

Catalogue of the New Orleans Exhibit of Economic Entomology. By Charles V. Riley. Washington: Judd & Detweiler. Pp. 95.

Report of the Entomologist, U. S. Department of Agriculture, for 1884. Washington: Government Printing-Office. Pp. 150.

Message of John M. Hamilton, Governor of Illinois. Springfield: H. W. Rokker. Pp. 21.

Evolution. By George D. Armstrong. Norfolk, Va. Pp. 22.

Connecticut Agricultural Experiment Station. Report for 1884. New Haven: Tuttle, Morehouse & Taylor, State Printers. Pp. 180.

A Correlation Theory of Color Perception. By Charles A. Oliver. Philadelphia. Pp. 29.

Rose Polytechnic Institute, Terre Haute, Ind. Third Annual Catalogue. Pp. 38.

A Study of the Nutritive Value of Branny Foods. By N. A. Randolph, M. D., and A. E. Roussel, M. D. Philadelphia. Pp. 20.

Contributions from the Chemical Laboratory of Harvard College. By Charles A. Maybery and others. Pp. 16.

The Geology of Bermuda. By William North Rice. Washington: Government Printing-Office. Pp. 32, with Plates.

Wesleyan University. Report of the Curator of the Museum. Pp. 8.

On the so-called Bird-Track Sculptures in Ohio. A Glacial Pebble, Fired Stones, and Prehistoric Implements. Impression of the figures on a "Meday stick." All by Daniel G. Brinton, M. D. Philadelphia.

On the Xinca Indians of Guatemala. By Daniel G. Brinton, M. D. Pp. 9.

Bulletin of the Iowa Agricultural College. By Charles E. Bessey. Pp. 64.

Diccionario Tecnológico (Technological Dictionary). English-Spanish. Part XI. New York: N. Ponce de Leon. Pp. 64. 50 cents.

The Spanish Treaty opposed to Tariff Reform. New York Free Trade Club. New York: G. P. Putnam's Sons. Pp. 31.

Normal Language Lessons. By S. J. Sornberger. Syracuse, N. Y.: C. W. Bardeen. Pp. 81. 50 cents.

Underground Conduits. Report of International Electrical Exhibition. Philadelphia: Franklin Institute. Pp. 56.

Fire and Burglar Alarms and Annunciators. Report of International Electrical Exhibition. Philadelphia: Franklin Institute. Pp. 16.

Municipal Administration. By Robert Matthews. Rochester, N. Y. Pp. 16.

Alabama Weather Service. January, 1885. Agricultural and Mechanical College. Auburn. Pp. 17.

Whitestown Centennial Celebration. Historical Discourse. By Charles Tracy. Pp. 16.

Dynamite and Extra-Territorial Crime. By Francis Wharton, LL. D. Philadelphia. Pp. 28.

Symbolism and Science. By Lloyd P. Smith. Philadelphia: Privately printed. Pp. 28.

Aims and Methods of the Teaching of Physics. By Professor Charles K. Wead. Washington: Government Printing-Office. Pp. 158.

"The Inland Monthly." Vol. I, No. 2. Columbus, Ohio. Pp. 16. 15 cents a copy; $1.50 a year.

The Geological and Natural History Survey of Minnesota. N. H. Winchell, State Geologist. First Annual Report, 1872. Pp. 180, with Plates. Tenth Report, 1881. Pp. 260, with Plates. Eleventh Report, 1882. Pp. 220, with Maps. Twelfth Report, 1883. Pp. 334, with Plates.

Mind-Reading and Beyond. By William A. Hovey. Boston: Lee & Shepard. Pp. 201.

American Historical Association. Report of the Organization and Proceedings. By Herbert B. Adams, Secretary. Pp. 44. 50 cents. Studies in General History and the History of Civilization. By Andrew D. White. New York: G. P. Putnam's Sons. Pp. 28. 50 cents.

Resultados del Observatorio Nacional Argentino. (Results of the Argentine National Observatory.) By Benjamin A. Gould, Director. Vol. II, 1872. Pp. 296. Vol. III, 1873. Pp. 510. Vol. IV, 1873. Pp. 588. Buenos Ayres: Pablo E. Coni.

Catalogo de Zonas Estelares. (Zone Catalogue of Mean Positions of Stars.) Observed at the Argentine National Observatory. By Benjamin A. Gould. Vol. VII. Pp. 440. Vol. VIII. Pp. 424. Cordoba, Argentine Republic. Published at the Observatory.

"The Sanitary Engineer." Conducted by Henry C. Meyer. Vol. X. June to November, 1884. 140 William Street, New York. Pp. 612. $3.

Our Bodies, or How we Live. By Albert F. Blaisdell, M. D. Boston: Lee & Shepard. Pp. 285. 60 cents.

The Fallacy of the Present Theory of Sound. By Henry A. Mott, Jr. New York: John Wiley & Sons. Pp. 108. 50 cents.

The Mentor. By Alfred Ayres. New York: Funk & Wagnalls. Pp. 211.

The Care of Infants. By Sophia Jex-Blake, M. D. New York: Macmillan & Co. Pp. 108. 40 cents.

Alice's Adventures in Wonderland, and through the Looking-Glass. By Lewis Carroll. New York: Macmillan & Co. Pp. 192 and 224. 50 cents paper, 75 cents cloth.

Controlling Sex in Generation. By Samuel Hough Terry. New York: Fowler & Wells Company. Pp. 147. $1.

School-Keeping. How to do it. By Hiram Orcutt. Boston: New England Publishing Company. Pp. 244. $1.

Serapis. A Romance. By George Ebers. New York: William S. Gottsberger. Pp. 367. 90 cents.

Representative American Orations. By Alexander Johnston. New York: G. P. Putnam's Sons. Three vols. Pp. 282, 314, 405. $3.75.

Original Researches in Mineralogy and Chemistry. By J. Lawrence Smith. Edited by J. B. Martin, B. S., M. D. Louisville. Printed by John P. Morton & Co. 1884. Pp. 680.

The Rise of Intellectual Liberty from Thales to Copernicus. By Frederick May Holland. New York: Henry Holt & Co. 1885. Pp. 453. $3.50.

The Correspondence and Diaries of the late Right Hon. John Wilson Croker, LL. D., F. R. S., from 1809 to 1880. Edited by Louis J. Jennings. In two vols., with portrait. New York: Charles Scribner's Sons. 1884. Pp. 584 and 572.

Smithsonian Meteorological and Physical Tables. By Arnold Guyot. Fourth edition. Washington: Smithsonian Institution. Pp. 738.

Mining Camps. By Charles Howard Shinn. New York: Charles Scribner's Sons. Pp. 316. $2.

Diluvium; or, the End of the World. By George S. Pidgeon. St. Louis: Commercial Printing Company. Pp. 175.

The Patriarchal Theory. Based on the Papers of the late John Ferguson McLennan. Edited and completed by Donald McLennan. London: Macmillan & Co. Pp. 355. $4.

Mortality Experience of the Connecticut Mutual Life Insurance Company, 1846 to 1878. Hartford, Conn. Pp. 85, with Plates.

Tertiary Vertebrata. Book I. By E. D. Cope. Washington. U. S. Geological Survey of the Territories. Pp. 1009, with nearly 100 Plates.

POPULAR MISCELLANY.

Psychology of the Chimpanzee.—Dr. C. Pitfield Mitchell has published a "Study of the Psychology of the Chimpanzee," which he has made upon a specimen in captivity at the Central Park Menagerie, New York. On being introduced, the animal offers his right fore hand, and, grasping one of the fingers of his visitor, attempts to put it in his mouth. The extension of the hand, in meeting an acquaintance, is made with a pleased look of recognition, unmistakably the outcome of gratified social feeling, and is often accompanied with a presentation of the back to be scratched. The chimpanzee, seated in a chair at table before a bowl of milk, grasps the spoon with his right fore-hand, and feeds himself, wiping his lips with a napkin held in his left fore-hand. In using the spoon, the co-ordination of movements lacks precision, but none of the milk is spilled;

and, when the spoon is taken away, he whimpers to have it returned, but does not seem inclined to drink in the natural way. The outer and visible signs of laughter are comparatively simple; that species of laughter which is caused by the perception of incongruities was never witnessed, although a few attempts were made to evoke it, and although monkeys and dogs are known to be sensitive to ridicule. When disappointed, as when a piece of banana was taken away from him, the animal sulked, became angry, cried, and shook his hands. When introduced to his image in the looking-glass, he seemed fixed for an instant with surprise, then looked to the back of the mirror, and began to bite the frame and pull an attached cord. "Advancing to the front and examining the reflection of his person with evident satisfaction, he commenced, with absurdly sincere intentions, to make effusive demonstrations of love. He repeatedly pressed his lips and tongue to the glass, and, erecting himself to his full height, strutted, and grinned, and made obeisance in most ridiculous and amusing fashion. He was once seen to make signs to his image by spasmodic movements of his lips, without uttering any audible sound. He again looked behind the mirror, and again fell to biting the frame. He became still more angry and hit the glass, first with the left fore-hand and then with the left hind-hand, and continued to do so with such violence that we were finally compelled to break the spell. While eating some fruit, he saw himself in the glass, and ran away precipitately, that he might keep possession of his morsel." A colored India-rubber ball that emitted a musical note when squeezed was examined with timid curiosity at first. "At length, he took the ball in his hands, not seeming afraid, and tried by gentle pressure, in imperfect imitation of what he had seen me do, to evoke its note. Failing in this, he commenced to hit it forcibly with the knuckles, and grinned with pleasure when the sound was produced. He then hit it violently, drawing the upper lip over the upper row of teeth, looking as if delighted in the exercise of his powers. He was allowed to see a piece of fruit put in a tin box or canister, and the latter closed by a firm adjustment of the lid. He very quickly applied the teeth, not the fingers, to remove the lid, and, having succeeded in doing so, extracted the fruit. But, seeing a similar cover on the opposite end of the canister, the previous association of contiguity between an adjusted cover and inclosed fruit forced him unreasoningly to remove this cover also."

The New England Meteorological Society.—The New England Meteorological Society was formed in June, 1884, to advance the study of atmospheric phenomena in New England, and to collect and diffuse information in meteorology. Its meetings are held on the third Tuesdays of October, January, and April, at places designated for each meeting. It publishes a monthly bulletin, containing a summary of the meteorological conditions of the preceding month, with other items of interest, which is supplied to members. Observations are welcomed from every one, and circulars and blanks to aid in making them are sent to those who desire them. The society is making arrangements for the display of daily weather-signals with railroads, postmasters, town authorities, and others, and contemplates the institution of investigations on the subject of ozone in its relations with epidemic disease. For carrying out its work, it relies wholly on the fees of membership, three dollars a year each member. Hence all interested in its work are invited to apply for membership to W. S. Davis, Secretary, Cambridge, Massachusetts.

Heavy Ordnance for National Defense.—In a pamphlet on "Heavy Ordnance for National Defense," Lieutenant W. H. Jaques, of the United States Navy, shows that we are in pressing need of guns to make our fortifications of value; that the most practicable type of the guns that are required is that represented by the system of Mr. J. Vavasseur, of London; and that there are no establishments in the United States possessing sufficient plant and experience to manufacture them on the scale that is demanded. In answering the question, What is the best method of supply of such guns, he shows, by cogent reasons, that the Government can not depend on foreign supply or private industries, and should not rely on its own factories alone. That which suggests itself to

him as the most feasible way for securing a provision of heavy ordnance is, for the Government to make arrangements for obtaining a supply of tempered steel from private industries, and provide for the fabrication of the guns—that is, for the machining and assembling of the parts, and the sighting of the guns—in its own factories, of which there should be two, one for the army and one for the navy. For this purpose appropriations should be made immediately for the purchase of steel, so that manufacturers may prepare to furnish it.

Scorpion-Lore verified.—A correspondent of "Land and Water," who has lived in Jamaica, has verified some of the curious stories that are told about scorpions. Having found one of these creatures among some old papers, he tried the experiment of blowing upon it, to test the verity of the tradition that a scorpion will not move under such circumstances. Somewhat to the experimenter's astonishment, the animal stopped at once, and flattened himself close to the paper on which he had been running, and would not move even when he was prodded with a pencil, or the paper to which he clung was shaken. As soon as the blowing was discontinued, the scorpion advanced cautiously, only to stop again at the slightest breath. Another experiment was made with regard to the readiness of scorpions to sting themselves to death. A circle of burning sticks was laid three yards in diameter, and the scorpion was placed in the center of it. The fire was not so hot but that the temperature was endurable within a few inches of it, and the center of the circle was cool. The scorpion made several desperate efforts to escape, and finding it could not, "retired almost into the exact center of the circle, and there in a tragic manner raised his tail till the sting or spur was close to his head, gave himself two deliberate prods in the back of his neck, and thus miserably perished by his own hand." An accidental observation enabled the writer to verify the story that the young of scorpions live upon the back of their mother. While he was playing billiards, something fell from the roof of the building upon the table. It proved to be a female scorpion, and from it ran away in every direction a number of perfectly formed scorpions, about a quarter of an inch long, of which thirty-eight were killed. The mother was in the throes of death, her body having been entirely eaten away by the brood. The negro attendant of the billiard-room said that the young scorpions always lived thus at the expense of their mother's life.

Local Variations in Thermometers.—Mr. H. A. Paul has called attention to discrepancies in the observations of temperatures which can not be covered by the ordinary precautions in the exposure and reading of thermometers, nor even by those more carefully devised ones recommended by Mr. H. A. Hazen, of the Signal-Service Office, in his recent paper on "Thermometer Exposure." According to Professor T. C. Mendenhall, of the Ohio State Weather Service, "the means of the thermometrical readings of the twenty State Service stations on the nights of the 21st and 25th of January, 1884, differed by respectively 12·4° and 14·7° Fahr. from those of the four Signal-Service stations. At Columbus a difference of 27° appeared between the reading of a thermometer on the north side of a stone building, and that of the State Service instrument in an open lot three miles distant. This circumstance indicates that the true minimum can not be got in a city or to the leeward of it when a moderate breeze is blowing. It may be questioned also whether exposure near the ground, where the conditions must vary with the local character of the surface, can be relied upon as a measure of the average state of the atmosphere for a few hundred or a few thousand feet overhead. Hence a plan of exposure on high, open scaffoldings would be highly desirable. At any rate, meteorological stations, especially those of the Signal Service, which is engaged in predicting the weather conditions for large areas, will have to be moved into the country, and probably to moderately elevated points, before the best results can be obtained."

The Great Bore of the Amazon.—Mr. John C. Branner, formerly of the Imperial Geological Commission of Brazil, has published a paper on the pororóca, or bore, of the Amazon, a manifestation of force peculiar to the northern division of the mouth of

the great river, of which the inhabitants of the adjacent country stand in extreme terror. It was not his privilege to witness an exhibition of the phenomenon, although he much wished to do so, while the people with whom he was staying desired that he or any one else should not, but he observed some of its effects and had the scene described to him. The most impressive manifestations of the force of the wave are near the mouth of the Araguary River. An eye-witness of one of the appearances of the pororóca, at that place, one of a party of soldiers, related that "shortly after the tide had stopped running out they saw something coming toward them from the ocean in a long white line, which grew bigger and whiter as it approached. Then there was a sound like the rumbling of distant thunder, which grew louder and louder as the white line came nearer, until it seemed as if the whole ocean had risen up, and was coming charging and thundering down on them, boiling over the edge of this pile of water like an endless cataract, from four to seven metres high, that spread across the whole eastern horizon. This was the pororóca! When they saw it coming, the crew became utterly demoralized, and fell to crying and praying in the bottom of the boat, expecting that it would certainly be dashed to pieces, and they themselves be drowned. The pilot, however, had the presence of mind to heave anchor before the wall of waters struck them; and, when it did strike, they were first pitched violently forward, and then lifted, and left rolling and tossing like a cork on the foaming sea it left behind, the boat nearly filled with water. But their trouble was not yet ended; for, before they had emptied the boat, two other such seas came down on them at short intervals, tossing them in the same manner, and finally leaving them within a stone's-throw of the river-bank, when another such wave would have dashed them on the shore. They had been anchored near the middle of the stream before the waves struck them, and the stream at this place is several miles wide." The signs of the devastation wrought upon the land by this gigantic wave are very impressive. Great trees, dense tropical forests, "uprooted, torn, and swept away like chaff"—for the most powerful roots of the largest trees can not withstand its rush; the destruction of the banks for some distance inland; and the formation of new land in places, are among the signs of its ravages. The pororóca is an accompaniment of the spring tides, and is due to the resistance offered to the tidal waves by the sand-bars and narrow channels which they have to meet. Its effects are most marked in the northern channels of the mouth of the Amazon, while little is known of it in the southern channels.

Drift-Copper in Iowa.—Mr. A. R. Fulton, president, read a paper, before a recent meeting of the Des Moines Academy of Science, on the pieces of native copper that occasionally occur in the drift of Iowa. He named several specimens that had been found in different parts of the State, varying from ten ounces to thirty pounds in weight, all identical in appearance with the native copper of the Lake Superior district. They had doubtless been brought down from there by glacial action, and this made it probable that the glacial current had some time during the Ice age flowed in a southwest direction. So, pieces of lead-ore have been found in parts of the State southwest of the lead-region around Dubuque, pointing to the same supposition.

Sowing Fertilizers.—Professor Storer, of the Bussey Institution, has made some experiments to determine the quantity of given fertilizers which a man would naturally throw from his hand in sowing an acre field. Having measured off a half-acre, he employed a careful laborer, accustomed to such work, to scatter the fertilizers over the soil, directing him to sow them as if he were sowing grain thickly. Doubling the amount actually sowed on the half-acre to adapt the proportion to the standard of a whole acre, the quantities sown were, to the acre: of nitrate of soda, 214 pounds; of muriate of potash, 173 pounds; of superphosphate of lime, 173 pounds; of blood, bone, and meat-dust fertilizer, 124 pounds. All of the substances were quite finely powdered up, except the nitrate of soda. The blood, bone, and meat-dust fertilizer weighed 50 pounds to the bushel; the superphosphate of soda, 68 pounds; the muriate of soda, 69 pounds; and the nitrate of soda, 88 pounds. The experiment was repeated with

a student of the institution, "an exceptionally intelligent American of one-and-twenty years," without much experience in that work, to do the sowing, and who moved as rapidly as the other man had moved deliberately. He scattered nitrate of soda at the rate of 194 pounds to the acre, and muriate of potash at the rate of 116 pounds. The laborer's work may be regarded as a useful indication of what would actually happen in case the specified fertilizers, says Professor Storer, were sown by hand. It will be noticed that the figures of the table agree very well with certain rules or statements current in agricultural journals, concerning the amounts of saline manures proper to be applied in practice; and it may well be true that some of these rules were originally based upon observations of the amounts of material that a man could conveniently scatter.

Suicide a Product of Fast Modern Life.—The "Lancet," noticing the increased prominence which suicides have appeared to assume in recent years, and believing that a large proportion of those crimes are the deliberate, conscious acts of persons overburdened with the cares of life or dreading some terror, attributes the increase to the fast rate of modern life. Boys and girls, it says, "are men and women in their acquaintance with and experiences of life and its so-called pleasures and sorrows, at an age when our grandparents were innocent children in the nursery. . . . Life is played out before its meridian is reached, or the burden of responsibility is thrust upon the consciousness at a period when the mind can not in the nature of things be competent to cope with its weight and attendant difficulties. . . . Forced education, commenced too early in life and pressed too fast, is helping to make existence increasingly difficult. . . . Hasty and too early marriages, too anxious struggles for success in life, too hazardous adventures in business enterprise, the rush of undisciplined and untrained minds into the arena of intellectual strife, and, above all, that swinging of the self-consciousness, pendulum-like, between excess in rigor of self-control and untempered license, which constitutes the inner experience of too many, are proximate causes of the break-down or agony of distress which ends in suicide. The underlying cause is impatience, social, domestic, and personal, of the period of preparation which Nature has ordained to stand on the threshold of life, but which the haste of progress treats as delay."

Oil and Earths as Food for Mice.—Professor Storer, of the Bussey Institution, has discovered that mice, when short of food, are capable of eating putty and of living upon the oil which they assimilate from it. Their capacity for feeding upon oil was demonstrated to him when one morning he found the wicks of the lamps which his workmen had left overnight in the cellar drawn and combed out, and the oil all sucked from them. Some months later he had several panes of glass set in the windows with new putty; a few days afterward he found the putty all eaten off. After making these observations, he began experimenting. He caged some mice, and, having fed them oats till they became accustomed to their new quarters, he cut down the supply of oats to just enough to keep them in good case, and gave fresh putty—ten or twelve balls, large enough to just pass through a three-eighth-inch hole to three mice. This putty, weighing twenty grammes (16·7 grammes of whiting and 3·3 grammes of oil), furnished five and a half grammes of whiting, or one third of its weight, to each animal. The whiting was passed off as an oilless dung, which became very large, white, and friable. It was relatively the same as if a man of about one hundred and fifty pounds weight were to eat and pass off fifty pounds of chalk a day! The mice would eat no more than the quantity named. If their allowance was increased, the surplus was left. To prove that it was for the sake of the oil that the putty was eaten, balls of whiting mixed with water, and of gypsum and water, were tried. They were not eaten; only a few of them were scratched enough to satisfy the mice that there was no oil in them. Red ochre when substituted for the whiting was eaten the first day, with the production of red dung, but was not eaten on the second day. It was better relished when mixed with whiting, but the mice soon tired of it in that shape. Yellow ochre was hardly more ac-

ceptable than red. Mixtures of linseed-oil and gypsum were eaten freely, but not so freely as the whiting mixture. Carbonate of baryta proved to be poisonous to the animals, but the poison seemed to be neutralized when carbonate of lime was mixed with it. Carbonate of lead seemed to act as a poison, but not so deadly, provided it was mixed with whiting, as it might have been supposed to be. Clay was not appreciated by the mice, but was eaten when mixed with whiting. Experiments with various results were also tried with sulphate of baryta, silica, carbonate and oxide of zinc (both eventually producing death), slaked lime (of which only one of the mice would eat enough to kill him), and whiting and sirup, which was eaten freely. Similar experiments were tried on rats, with similar results.

Rainfall as affected by Wind. — The proper construction and location of rain-gauges to secure measurements agreeing with the average rainfall on the surrounding district has been a much-discussed problem. In 1766 Dr. Heberden observed that gauges on the ground collect generally a larger quantity of rain than gauges on the sides and roofs of buildings. As a summary of facts since learned, G. E. Curtis, in "Signal-Service Notes," No. 16, quotes the following from an article published by Symons in 1878: "The greater part of the decrease is due to wind. The stronger the wind, the greater the decrease with elevation. The less the diameter of the elevated gauge, the less will it indicate. A gauge on the leeward side of a tower may collect as much rain as one on the ground. A gauge in the middle of a large roof may, notwithstanding its height, collect very nearly the same as one upon the ground." In the following year Symons further stated that "there is no evidence of any difference between the fall of rain at various heights from sixty to two hundred and sixty feet above the ground." How the variation in the vicinity of buildings can depend on the wind was explained in 1861 by W. S. Jevons, who said that a stream of air meeting an obstacle leaps over it, flowing with increased velocity above it, as a river flows fastest through narrows. When two equal drops of rain fall into a current of air at points where the velocity is not the same, one drop will either approach toward or recede from the other, and the quantity of rain falling on the space beneath will be increased or diminished. The large rainfall registered at the Signal-Service station on Mount Washington has recently been specially investigated. Four extra gauges, three inches in diameter, were set up seventy-five feet respectively north, east, south, and west from the station-gauge. The observations of thirteen months showed that precipitation varies materially within one or two hundred feet. It was found also that the windward gauges generally recorded the least rain, the central gauges more, and the leeward gauges the most. Hence it is concluded that the wind affects the distribution of rain on the summit of Mount Washington in the same way as on the tops of buildings. During this period the station-gauge, which is eight inches in diameter, was found to give larger readings than the others, and a three-inch gauge was set up near the large one for comparison under the same conditions. The conclusion reached was that the discrepancy was due to insufficient collection by the smaller gauge, and varied as the square of the wind's velocity. European observers have noticed no such differences between the measurements of three-inch gauges and larger sizes, but their observations were made when the velocity of the wind did not exceed twenty miles an hour, while on Mount Washington it reached seventy-five miles an hour.

The Food of Animals.—The question whether the distinction between herbivorous and carnivorous animals is as clear as it has been supposed to be is discussed in the "Field Naturalist" and the "Journal of Science." The prevailing theory is that the primary animal life was herbivorous; and this must have been the case with the earliest and lowest forms, which had nothing but plants on which to feed; but among vertebrates, and especially among mammalia, the earliest forms seem to have been zoöphagous or animal-eating. Among fishes, amphibians, and reptiles, even in the earlier geological epochs, the vegetable feeders are found in a minority. The earliest fossil

birds were plainly fitted for a predatory life; and the lowest and earliest forms among mammals are decidedly zoöphagous. It may even be permissible to ask if among mammals the purely plant-eating forms have not been developed from a zoöphagous or at least from an omnivorous stock. The only large group which contains no zoöphagous or omnivorous members, that of the ruminants, is characterized by its complicated and highly specialized digestive organs, "evidently modified from the normal mammalian type, so as to be adapted to a purely vegetable diet." Numerous animals are zoöphagous at one period of their lives and plant-eating at another, and experience a natural and normal change. Thus all mammals begin life as milk-eaters. Likewise all birds begin with a diet of insects and worms or of half-digested food disgorged from the crop of their parents. Changes arising from scarcity of food, or from caprice, are also on record. Domesticated dogs and cats often partake of vegetable matter. Among wild animals the change in diet when it occurs is most generally from vegetable to animal. Curiously, when any species has adopted a new diet, it shows a great disinclination to return to its former food. The majority of warm-blooded animals may, however, be regarded as omnivorous, in so far that they consume both animal and vegetable food. Apes and monkeys, generally classed with vegetarians, "never omit an opportunity of robbing a bird's nest, and feed with avidity upon a great variety of insects." The bears and their allies, except the so-called polar bear, carnivores, seem to prefer fruits, roots, honey, insects, and even grain before it is ripened and hardened. "There is no satisfactory evidence that any of the cats in a wild state will consume vegetable matter, but at least two groups of the *Canidæ*—the foxes and the jackals—are not averse to fruit." Among the rodents an omnivorous character is becoming more and more fully established. The *Solidungula*, or horse kind, and the ruminants are, so far as is known, strictly vegetarians; but the other sub-order of the *Ungulata*, that of the pachyderms, includes the swine, the most typically omnivorous animals. Among the birds, the number of purely plant-eating species is relatively smaller, that of the exclusively zoöphagous larger, and that of the forms recognized as omnivorous is increasing as our knowledge of their habits extends. Thus the animal-eating and plant-eating forms of animal life are not separated from each other by any sharply marked characters, but are connected by a multitude of creatures intermediate in their organization, and consequently adapted for a mixed diet.

Health and Density of Population.—Professor de Chaumont recently illustrated the influence of density of population on health, by comparing London and Paris. In Paris every individual had an area of about forty square metres, while in London he had eighty. The result of the difference was clearly shown, not only in the lower death-rate in a larger population, but in the character of the diseases, while some diseases—scarlet fever, for instance—were more severe in London than on the Continent; others, such as typhoid fever and diphtheria, were much more common and fatal in the large cities of the Continent than they were in England. In London, the streets were filthy and the sewers abominable, but the houses were the perfection of cleanliness; whereas, in Paris, one might give a dinner-party in the sewers, and the streets were perfectly clean, but the houses were abominably filthy. In Paris, all the filth was kept in or under the houses, while in London it was all sent away. The result was shown in the differences in the health of the two cities, particularly in diphtheria, which was described by French sanitarians as the scourge of their country, while in London it took a comparatively low position in the class of zymotic diseases.

Chinese Acupuncture.—The "North China Herald" gives some curious illustrations of the skill of Chinese doctors in cauterization and acupuncture. With two copper coins as his only tools a Mantchoo peasant produced an effectual counter-irritation in a case of slight sunstroke. Acupuncture is performed first in the hollow of the elbow of each arm, and is regarded as successful if blood flows from the wound. If the blood does not appear, the case is regarded as grave, and the operation is repeated in the abdomen, with drawing back and forth of the needle. If the patient shows signs of

pain, or blood is drawn, a poultice is applied, and recovery is regarded as almost certain. If the blood does not flow, or the patient does not suffer, the case is given up. A case is quoted in which a young Chinese was instantly relieved of the cramp of cholera by this process. The Chinese explanation of their treatment is that, when the blood is in the poisoned condition which induces the choleraic symptoms, it becomes thick and accumulates in certain parts of the body, from which it must be withdrawn.

Development of Zuni Civilization.—Mr. F. H. Cushing explained before the British Association his theory of the manner in which the present civilization of the Zuñis rose by a genuine process of self-development from a low condition of barbarism, in which he finds every reason to believe those Indians originally existed. The brush-covered wigwam in which they first dwelt gave way to a small building of lava-stone, or a cliff-dwelling, and that to the pueblo-house, which is both cliff and dwelling in one. Their earliest vessels were gourds. They incased them in wicker-work for safer transportation; then took the wicker-work alone, and had a basket; then plastered the basket with clay to make it tight, and got the idea of a pottery-vessel. The first ornamentation of their pottery was derived from the imitation of this wicker-work frame. And all this took only a few centuries—nothing near the numerous cycles of ages which some anthropologists imagine it must have taken man to reach a civilized state.

Family Relations of the Muata Yanvo.—Dr. Pogge and Max Buchner have described the people of the Muata Yanvo, or Matianvo of Livingstone, as, although fetich-worshipers, practicing circumcision, a "fine warlike race, unhappily addicted to slave-hunting, though far in advance of some neighboring tribes, and living under feudal institutions." "Among many peculiar customs," says General Lefroy, "is one which invests one of the king's half-sisters, under the designation of the Lukokescha, with the second authority in the kingdom. She is forbidden to marry, but permitted a sort of morganatic alliance with a slave, any offspring being ruthlessly destroyed, and, on the death of the king, she has the principal voice in determining his successor, who, however, must be selected from among the sons of the late king. . . . The extraordinary custom prevails here that a man's children do not belong to him, but to the eldest brother of their mother; and, should a child die, the father must make compensation."

Treatment for the Opium-Habit.—In his little pamphlet on this subject, Dr. Asa P. Meylert says that in all cases where unrestrained the opium *habitué* takes a larger quantity than would suffice him. The method of cure by gradual reduction alone he has tried in one case at the patient's request, but does not propose to repeat the experiment. Every reduction was attended with severe suffering. In another case, he tried to reduce gradually, using tonics to sustain the patient, but no narcotics, nor a substitute of any kind. The case was that of a woman, whose general health was good, whose will-power was unusually strong, who had not taken opium long, and was not taking a very large quantity—thirty grains of crude opium daily. It was a most favorable opportunity to try this method. The result proved that, notwithstanding the tonic treatment, she found a daily reduction of four per cent intolerable. We must therefore—if we adopt this method—consider something less than four per cent as adapted to the average patient. Suppose that the average consumption be estimated at ten grains of morphia daily—and this is a low estimate. Suppose, again, that the patient continues the drug to the one tenth grain before leaving it off altogether—and this would be a minimum limit without special treatment: to reduce from ten grains to one tenth grain, at three and one half per cent daily, would require one hundred and thirty days, or nearly four and a half months; at one per cent, four hundred and fifty-nine days, or over fifteen months. Those who know how easily the opium patient is alarmed by any sudden shock, and how naturally relief is sought from the bottle for every ill or mischance in life, need no assurance that a cure which must extend over so long a time is utterly impracticable for the average patient, outside an institution. There re-

mains but one general course of treatment which Dr. Meylert deems worthy of consideration—that by substitution. This consists in gradually reducing the drug, substituting, however, some narcotic, sedative, or soporific. He knows of no antidote which will allow the immediate cessation of morphia without pain; the best offered by the nostrum-venders being only a poor attempt at reduction and substitution. Dr. T. D. Crothers states that analyses of fourteen so-called opium antidotes showed the presence of morphia in every one.

A Blind Man's Capacities.—The death of Mr. Fawcett, the blind English statesman, has brought out a proposition to create a fund in memory of him which shall be most appropriately devoted to the furtherance of the higher education of the blind. Mr. Fawcett himself was a splendid example of what a blind man can accomplish when he sets his heart on the work he engages in; yet what he did, he did wholly without the systematic instruction which is given in some institutions for the blind. His public work was of the best, so that he was one of the most valued officers of the British Government. Besides this, he was able to ride, to walk, to skate, to row, to fish, and to climb the Alps. Though the affliction of having become blind after having seen may be considered greater than that of having been blind from birth, Mr. Fawcett was able to enjoy much from having once seen. "In his walks with his friends, he would sometimes wish to go to a place where he could have 'a view'—that is, where his companions could describe to him scenes once familiar to his sight—and more than one of those who have met him have been struck on being told by the professor (as a result of friendly inquiries from third parties as to their appearance) that he was glad to see them look so well." Thus he was able to make the recollection of what he had seen a source of pleasure to himself. Blind asylums were first founded as a kind of hospitals for incurables, without any idea of teaching anything to their inmates. But even then a few individual efforts had been made to instruct the blind. Bernouilli, more than two hundred years ago, is reported to have taught a blind girl at Geneva how to write. Saunderson and Weissenberg did the same for themselves. The attempt further to develop the idea was made in Paris exactly a hundred years ago, when Fraulein Paradies, of Vienna, who had made some efforts in the same direction, communicating with persons in France, an institution was established, in which it was proposed to give a general education to the blind, as well as to train them in special faculties.

Origin of Chinese Ancestral Worship.—According to a writer in the "North China Mail," the Chinese ancestral worship was maintained in most ancient times on the ground that the souls of the dead survive. The present, it was believed, is a part only of human existence, and men continue to be after death what they have become before it. Hence the honors accorded to men of rank in their lifetime were continued to them after death. In the course of ages, and in the vicissitudes of religious ideas, men came to believe more definitely in the possibility of communications with supernatural beings. In the twelfth century before the Christian era it was a distinct belief that the thoughts of the sages were to them a revelation from above. A few centuries subsequently we find for the first time great men transferred in the popular imagination to the sky, it being believed that their souls took up their abode in certain constellations. This was due to the fact that the ideas of immortality had taken a new shape, and that the philosophy of the times regarded the stars of heaven as the pure essences of the grosser things belonging to this world. The pure is heavenly and the gross earthly, and, therefore, that which is purest on earth ascends to the regions of the stars. At the same time hermits and other ascetics began to be credited with the power of acquiring extraordinary longevity, and the stork became the animal which the immortals preferred to ride above all others. The idea of plants having the property of conferring immunity from death soon sprang up, and the red fungus *Polypores lucidus* was regarded as the most efficacious of such plants. Its red color was among the circumstances that gave it its reputation, for at this time the five colors of Babylonian astrology had been ac-

cepted as indications of good and evil fortune. This connection of a red color with the notion of immortality through the medium of good and bad luck led to the adoption of cinnabar as the philosopher's stone, and thus to the construction of the whole system of alchemy; but the plant was regarded first.

Over-pressure in English Board-Schools.—A controversy is going on in England over the question whether or not over-pressure is exerted in the elementary schools. Much depends, in the debate, on the definition to be attached to the term over-pressure. Edith Lupton would include in it any physical or mental injury done to any child as a consequence of the carrying out of the education acts. The school-officers would require that the child should have been previously entirely healthy; but Dr. B. W. Richardson is quoted as saying that such a child in our present state of civilization does not exist. Dr. Crichton Browne has reported, after examining the London schools, that the evil in them is real, and is working injury upon the children. It is exerted by the "keeping in" after school-hours of children, usually those who are from any cause behind with their work and have to be pushed so as to be ready for the examination, and in the imposition of home-lessons. The prime motive to both these impositions is the necessity which exists for forcing backward pupils to the examination level. The very fact that these children are backward is evidence that they are not as competent to sustain the regular school-work as their brighter fellows; yet they are the ones upon whom the additional charges are laid. "The influence of that emotional excitement caused by the approach of an examination," says Dr. Browne, "is really one of the most dangerous elements in educational over-pressure," and the "examination-fever," as it has been called, "is now endemic in the metropolis." Many of the London children go to the school partially starved, through having to depend upon food which, though it may be abundant, is innutritious. They "want blood, and we offer them a little brain-polish; they ask for bread, and receive a problem; milk, and the tonic-sol-fa system is introduced to them." Some come breakfastless to school, because they must be in their places punctually, and they have no time to eat breakfast. More than a third of the children in the elementary schools of London are represented to be suffering habitually from headaches, and these come on for the most part in the latter half of the day, when the brain has become exhausted, and the pressure of work tells most seriously from it. Many are troubled with sleeplessness, generally caused by their thinking over their lessons, particularly their arithmetic-lessons. Parents frequently complain to teachers that the family are disturbed by the children talking of their lessons in their sleep. Dr. Crichton Browne believes that a considerable part of the increase in nervous and brain diseases, and neuralgia and short-sightedness, is attributable to this over-pressure. He found nothing, however, to complain of in Scotland, where the children are vigorous, well fed and clothed and taken care of. These conclusions have been scornfully contradicted by the friends of the school-boards, but Edith Lupton gives Dr. Browne a strong support by showing that even the school-inspectors had not means of ascertaining the facts at all comparable with those which he used. Thus, at Bradford, the official inspection was done at a rate which gave an average of one minute for the personal examination of each child. "Out of that time had to be taken the time required for inspecting log-book, school premises, sanitary arrangements, teachers, and pupil-teachers. The children had to be examined in reading, writing, arithmetic, sewing, English, geography, elementary science, history, drawing, and algebra. The infant department, in facts about animals, coal, gas, salt, form, color, food, plants, clothing, rain, frost, etc., etc.; modeling, geometrical drawing, weaving, planting, drill. Then there was the merit grant in all the schools, organization and discipline, intelligence and instruction, behavior of children, inspection of the exemption schedule and its authentication 'by attendance officers,'" preliminarily to which special inquiries had to be made personally. Furthermore, the inspector "had to satisfy himself that in the daily management of the school the children were being brought up in habits of punctuality,

good manners and language, cleanliness and neatness, cheerful obedience to duty, consideration and respect for others, honor and truthfulness in word and act; and not only that regard had been paid in classifying them as to their health, age, and mental capacity, but that the dull and delicate had not been at any time within the preceding year unduly pressed. And all this in five hours" for three hundred children! Miss Lupton adds instances of actual and serious overpressure which had come under her own observation.

NOTES.

THE true source of the Mississippi River has been determined, as he claims, by Captain Willard Glazier, who led an expedition in search of it in 1881, to be a lake a few miles south of Itasca Lake, and not less than three feet above it, in latitude 47° 13′ 25″. Captain Glazier's party proceeded in canoes *via* Leech Lake to Lake Itasca, and, accompanied by an old Indian guide, pushed down to the new lake, which is of considerable size, and is named after the discoverer, Lake Glazier. It is 1,578 feet above the Atlantic Ocean. The length of the Mississippi, calculated to it, is 3,184 miles. The lake has remained in obscurity so long on account of the wild condition of the country, and because it is out of the usual route of the fur-trade.

SOME very satisfactory experiments in the purification by artificial aëration of the water supplied the city have been reported to the Franklin Institute, Philadelphia. On comparison with the ordinary supply, the percentage of oxygen in the aërated water was seventeen greater than before; the amount of carbonic acid was fifty-three per cent; and of total dissolved gases, sixteen per cent more. "The percentage of free oxygen," says the report, "represents the excess over and above what was required to effect the oxidation of the dissolved impurities."

DR. JOHN ANTHONY, who has had much experience in Egypt and Asia Minor, regards the difference between a dromedary and a camel as largely a matter of speed. The former bears about the same relation to the latter as the trotting-horse to the cart-horse. The dromedary is credited with trotting about twenty miles an hour, while a regular camel or burden-bearer can not be forced more than some four or five miles an hour. The Egyptian camel and the dromedary have one hump. Dr. Anthony never saw a "Bactrian" or two-humped camel till he was east of the Crimea.

PROFESSOR E. COHN, of Breslau, has published some interesting observations made by the naturalist Leeuwenhoek on microscopic organisms in the cleanings of his teeth in 1683, or more than two hundred years ago. The observer distinguished several kinds of organisms, and described them so precisely that they would be easily recognizable. One resembled a rod—the bacillus; others, bending in curves, the bacteria; a third kind, creeping in snake-fashion, a vibrio; another kind, extremely minute, and resembling a swarm of flies rolled up in a ball, was evidently the micrococcus. Leeuwenhoek marveled that these things could live in his mouth. Two remarkable circumstances about this story are, that Leeuwenhoek used the imperfect instruments of his time with wonderful skill, and that so long a time elapsed before any progress was made in the study of bacteriology.

DR. A. L. FROTHINGHAM, 29 Cathedral Street, Baltimore, has issued a prospectus for the "American Journal of Archæology," to be published quarterly and devoted to the study of the whole field of archæology, Oriental, classical, early Christian, mediæval, and American, and to serve as the official organ of the Archæological Institute of America. It will be illustrated. Professor Frothingham will be assisted by Professor C. L. Norton, of Harvard College, as advisory editor, and by Dr. A. Emerson, Mr. T. W. Ludlam, Professor Allen Marquand, Mr. A. R. Marsh, and Mr. C. C. Perkins, as special editors. The subscription price will be three dollars and fifty cents a year. In addition, subscriptions are invited from the friends of archæological studies for the formation of a reserve fund to meet the deficit which must occur during the first few years of the "Journal's" existence.

ACCORDING to the statements of Professor Poleck, of Breslau, the "house-fungus" (*Merulius lacrymans*), which has recently become so extensively spread in Europe, is most destructive to wood that contains most mineral matter. The richer the wood in phosphates and potash compounds the more does the fungus flourish. Now, pine-wood felled in the sap contains five times as much potash and eight times as much phosphoric acid as wood felled in the winter. Hence, it is better, for the preservation of the wood, to cut the trees late in the winter season.

M. OLZEWSKI reports that having obtained more considerable quantities of different liquefied gases, he caused liquid nitrogen to boil under a pressure of sixty millimetres at −214° C. (−353° Fahr.), when it became partly solidified. At the pressure of four millimetres, the ebullition, which took place at −225° C. (−363° Fahr.), determined the complete solidification of the

liquid. Carbonic oxide behaved in an analogous manner. Oxygen gave no sign of congelation when boiled at −211° C. (about −348° Fahr.).

M. Sacc announces that he has discovered a new alimentary substance in the seed of the cotton-tree, which is richer than any other known grain in nitrogenous matters. He believes that the flour of this seed is destined to take an important part in alimentation, and in the preparation of all kinds of paste, in which it acts as a substitute for milk.

M. Duclaux declares, in the French Academy of Sciences, that the vegetation of seeds is impossible in a soil wholly deprived of microbes.

An International Ornithological Congress was recently held at Vienna, at which a permanent committee was appointed to organize a system of regular observations of the movements, migrations, and habits of birds. It is intended to form a network of stations all over Europe, in which persons having a taste for such work and qualified to perform it are expected to lend their aid in forwarding the objects of the observations.

OBITUARY NOTES.

Mr. E. C. Rye, for fifteen years Librarian of the Royal Geographical Society, died February 7th, at about fifty-three years of age. He was distinguished in science as a student of *Coleoptera* and author of a book on "British Beetles"; he was also for eleven years editor of the "Zoölogical Record."

Professor Henry Lawrence Eustis, Dean of the Harvard Scientific School, died in Cambridge, Mass., January 11th, aged sixty-six years. He became Professor of Engineering in the Scientific School in 1849. He was the author of technical books on engineering science.

Dr. Gwyn Jeffries, one of the most eminent of European conchologists, died, January 24th, of apoplexy. He was born in Swansea in 1809, began his conchological studies by collecting shells on the beach when he was ten years old, and produced his first scientific paper in 1828. He was a pioneer in deep-sea research, having begun dredgings on his own account; he afterward participated in expeditions with Dr. Carpenter and Professor Wyville Thomson; subsequently pursuing similar researches in Davis Strait; and was a promoter of the Challenger Expedition. At the Montreal meeting of the British Association, he read a paper on the relations of species inhabiting the opposite coasts of the Atlantic. He was an active member of the British Association, and a member of numerous other learned societies.

Mr. Richard Atkinson Peacock, an English engineer and geologist, whose special study was the investigation of the causes of volcanoes and of subsidences of the earth, died in London, February 2d, in the seventy-fourth year of his age. He was the author of books on "What is and What is not the Cause of Activity in Earthquakes and Volcanoes," "On Steam as the Motive Power in Earthquakes and Volcanoes," and on "Physical and Historical Evidences of Vast Sinkings of Land on the North and West Coasts of France and Southwestern Coasts of England."

The death is announced of Professor Lucä, the Frankfort anatomist and anthropologist.

Mr. J. Turnbull Thomson, Surveyor-General of New Zealand, died on the 14th of October, aged sixty-three years. He was born in Northumberland, and went to New Zealand in 1856, after having spent seventeen years in the East India Company's service. He organized the New Zealand system of land-survey, which is very exact, and under which land-holders are secure as to their boundaries. He had been a Fellow of the Royal Geographical Society since 1848, to whose "Proceedings" he contributed a paper on the "Survey of the Province of Otago." He was author of several books on social and economical subjects, and papers on scientific and practical topics, many of which were published in the "Transactions" of the New Zealand Institute.

Dr. E. H. von Baumhauer, Perpetual Secretary of the Scientific Society of Holland, and formerly Professor of Chemistry in Amsterdam, died in Haarlem, January 18th, at the age of sixty-four years. He was most interested on the practical side of science, in which he introduced many useful applications, and was also known for his researches on meteorites, and for his universal meteorograph. He was active in measures for facilitating international exchanges of books, on a plan like that which is pursued at the Smithsonian Institution. He was a member of the Netherlands Commission at our Centennial Exhibition in 1876.

M. C. H. L. Dupuy de Lôme, an eminent French naval engineer, died in Paris, February 1st, aged sixty-eight years. His name has been identified with works of naval construction in his native country since 1850. During the siege of Paris by the Germans, he directed the experiments by which it was sought to make balloons useful in the defense of the city, and since that time he has been interested and engaged in seeking solutions of the question of the propulsion of balloons.

INDEX TO VOLUME XXVI.

INDEX.

PAGE

Abuse, The, of Political Power 273
Acupuncture, Chinese 859
Addresses, American Association 282
Addresses, British Association 138
Agnosticism, Last Words about 310
Agnostic Metaphysics 299
Agriculture, Field-Experiments in 498
Air-Wave, The Krakatoa, Velocities of 423
Alabama, The Cotton Production of 422
Alcoholic Trance 187
Allen, Grant 177, 468
Allen, W. F. 145
Amazon, The Great Bore of the 855
American Aspects of Anthropology 152
Animal Character, Oddities of 261
Animals, The Food of 858
Anthropology, American Aspects of 152
Apiculture 803
Architecture, The, of Town-Houses 379
Aristotle as a Zoölogist 796
Arithmetic, Advantages of a Binary 574
Armsby, Professor H. P. 498
Arrangement, Internal, of Town-Houses 826
Arts, Domestic, in Damaraland 99
Ascetic, An, Indian Tribe 717
Association, American, Addresses 282
Association, British, Addresses 138
Association, The American, at Philadelphia 124
Association, The French 285
Association, The, of Official Chemists 286
Astronomy, Pending Problems of 46
Aughey, Samuel 267

Beaver, More about the 267
Benedict, W. R. 731
Biedermann, Dr. 691
Birds'-Nests, Edible, Gathering 430
Birds, Why, sing 541
Birds, Wild, in Cities 718

PAGE
Bloody Sweat..... 357
Boas, Dr. Franz..... 768
Book Notices:
"A Naturalist's Rambles about Home" (Abbott)..... 128
"The Discoveries of America to the Year 1525" (Weise)..... 129
"Samuel Adams, the Man of the Town-Meeting" (Hosmer)..... 129
"On the Nature of Light" (Stokes)..... 129
"Chemistry" (Attfield)..... 130
"Electricity, Magnetism, and Electric Telegraphy" (Lockwood)..... 130
"Principles of Ventilation and Heating" (Billings)..... 130
"Natural Law in the Spiritual World" (Drummond)..... 131
"Forestry in Norway" (Brown)..... 131
"The New Physics" (Trowbridge)..... 132
"Hand-Book of the Dominion of Canada" (Dawson)..... 133
"Excessive Saving a Cause of Commercial Distress" (Crocker)..... 133
"Electrical Appliances of the Present Day" (Heap)..... 133
"The Fallacies in 'Progress and Poverty'" (Hanson)..... 134
"Cholera, and its Preventive and Curative Treatment" (Ray)..... 134
"New Method of recording the Motions of the Soft Palate" (Allen).. 134
"Formation of Poisons by Micro-Organisms" (Black)..... 134
"The Orchids of New England" (Baldwin)..... 134
"Taxation in the United States, 1789–1816" (Adams)..... 135
"Institutional Beginnings in a Western State" (Macy)..... 135
"Indian Money as a Factor in New England Civilization" (Weeden). 135
"Hand-Book for Horsewomen" (De Bussigny)..... 135
"Catholic" (Capel)..... 136
"Manual of Biblical Geography" (Hurlbut)..... 136
"Introduction to the Study of Modern Forest Economy" (Brown)... 136
"Forests and Forestry in Northern Russia," etc. (Brown)..... 136
"South Carolina" (Hammond)..... 136
"Relations between Religion and Science" (Exeter)..... 277
"Cottages" (Brunner)..... 278
"Commentaries on Law" (Wharton)..... 278
"Diseases of the Throat and Nose" (Mackenzie)..... 278
"Outline of the Future Religion of the World" (Stanley)..... 279
"Mineral Resources of the United States" (Williams)..... 279
"Education by doing" (Johnson)..... 279
"Life and Labor in the Far, Far West" (Barneby)..... 279
"Correspondences of the Bible" (Worcester)..... 280
"Geology and Mineral Resources of the James River Valley, Virginia" (Campbell)..... 280
"Arithmetical Aids"..... 280
"Grammar of the German Language" (Brandt)..... 280
"Reader of German Literature" (Rosenstengel)..... 280
"Tableaux de la Révolution Française" (Crane and Brun)..... 281
"Elements of Analytic Geometry" (Newcomb)..... 281
"Report of Smithsonian Board of Regents"..... 281
"A Compend of Geology" (Le Conte)..... 413
"The Destiny of Man" (Fiske)..... 414
"Shoppell's Building Plans" (Shoppell)..... 414

Book Notices: PAGE

"My Farm of Edgewood" (Mitchell) 415
"Forestry in the Mining Districts of the Ural Mountains," etc. (Brown) 415
"Comprehensive Anatomy, Physiology, and Hygiene" (Cutter)..... 415
"American Newspaper Annual" (Ayer) 415
"How we live" (Johonnot and Bouton)..... 416
"Book of Cats and Dogs," etc. (Johonnot)..... 416
"The True Issue" (Donnell)..... 416
"Wages and Tariffs" (Donnell)..... 416
"Outlines of Roman Law" (Morey)..... 416
"A Thousand Questions in American History"..... 417
"Book of Plant Descriptions" (Groff)..... 417
"Essays by 'Wheelbarrow'" 417
"Wonders and Curiosities of the Railway" (Kennedy) 417
"Lessons in Chemistry" (Greene)..... 417
"The Laws of Health" (Hutchison)..... 418
"Systematic Mineral Record" (Shepard)..... 418
"United States Commissioner of Fish. Report, 1880"..... 418
"Medical Jurisprudence and Toxicology" (Reese)..... 418
"Commissioner of Education. Report, 1882, 1883"..... 418
"Commissioner of Agriculture. Report, 1883"..... 419
"Geological Survey, New Jersey, 1883" (Cook)..... 419
"Our Birds in their Haunts" (Langille)..... 419
"Wonders of Plant-Life," etc. (Herrick)..... 419
"Magneto-Electric and Dynamo-Electric Machines" (Schellen)..... 420
"Cassell and Company's Holiday Catalogue"..... 420
"Migration Legend of the Creek Indians" (Gatschet)..... 420
"Principles of Political Economy" (Mill)..... 559
"A System of Psychology" (Thompson)..... 562
"The Reality of Religion" (Van Dyke)..... 563
"Thomas Carlyle" (Froude)..... 563
"Women, Plumbers, and Doctors" (Plunkett)..... 564
"The American Psychological Journal" (Parrish)..... 564
"Tenants of an Old Farm" (McCook)..... 565
"The Way out" (Bellamy)..... 565
"The Philosophy of a Future State" (English)..... 565
"Elementary Text-Book on Physics" (Anthony and Brackett)..... 566
"Young Folks' Ideas"..... 566
"An Appeal to Cæsar" (Tourgee)..... 566
"Fichte's Science of Knowledge" (Everett)..... 567
"Origin of Cultivated Plants" (De Candolle)..... 706
"The New Philosophy" (Paine)..... 708
"Text-Book of Botany" (Sachs)..... 708
"Rudimentary Society among Boys" (Johnson)..... 708
"Town and County Government" (Channing)..... 709
"Prehistoric America" (De Nadaillac)..... 709
"The Eclectic Physiology" (Brown)..... 709
"Icaria" (Shaw)..... 709
"Elements of Chemistry" (Norton)..... 710
"Archæological Tour in Mexico" (Bandelier)..... 710
"Science in Song" (Richards)..... 710

Book Notices: PAGE
"Reports of Meetings of Scientific Associations" ("Science")..... 710
"Representative British Orators" (Adams)..... 710
"Elementary Treatise on Analytic Mechanics" (Bowser)..... 711
"Elements of English Speech" (Choate)..... 711
"T. Lucreti Cari de Rerum Natura" (Kelsey)..... 711
"Country Cousins" (Ingersoll)..... 711
"Land and its Rent" (Walker)..... 712
"Public Relief and Private Charity" (Lowell)..... 712
"The Human Body" (Martin)..... 712
"Bermuda" (Dorr)..... 712
"Vocal and Action Language" (Kirby)..... 712
"The Rise of Intellectual Liberty, from Thales to Copernicus" (Holland)..... 845
"Second Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1880–'81" (Powell)..... 846
"Sixth Annual Report of the State Board of Health of Illinois" (Rauch)..... 847
"Notes on the Opium-Habit" (Meylert)..... 847
"Comparative Physiology and Psychology" (Clevenger)..... 847
"Annual Report of the Chief Signal-Officer to the Secretary of War for the Year 1883"..... 848
"Osteology of Numenius Longirostris" (Shufeldt)..... 848
"The Asiatic Cholera" (Hamilton)..... 848
"Comparative Study of the New High German Language, Theoretical and Practical" (Valentine)..... 848
"Description of Carcharodon Carcharias" (Stevenson)..... 848
"Black and White: Land, Labor, and Politics in the South" (Fortune)..... 849
"Degeneration the Law of Disease" (Merriam)..... 849
"Protection and Communism" (Rathbone)..... 849
"Ottawa Field-Naturalists' Club"..... 849
"The Sun"..... 849
"Journal of the New York Microscopical Society" (Braman)..... 849
"Original Researches in Mineralogy and Chemistry" (Smith)..... 850
"Poems of Sidney Lanier"..... 850
"Man in the Tertiaries" (Morse)..... 850
"The Agricultural Grasses of the United States" (Vasey)..... 850
"The Chemical Composition of American Grasses" (Richardson)..... 850
"United States Publications: Monthly Catalogue"..... 850
"The Story Hour" (Wixon)..... 850
"Proceedings of the American Society of Microscopists"..... 850
"Geonomy: Creation of the Continents by the Ocean-Currents" (Grimes)..... 851
"Sunlight"..... 851
"An Account of the Progress of Chemistry in the Year 1883" (Bolton)..... 851
"Rural Schools; Progress in the Past; Means of Improvement in the Future"..... 851
"The Composition and Methods of Analysis of Human Milk" (Leeds). 851
"The Journal of Mycology" (Kellerman, Ellis, and Everhart)..... 852

Book Notices: PAGE
"Notes on the Progress of Mineralogy in 1884" (Lewis)..... 852
"Mind in Medicine" (Bartol)..... 852
"Babyhood" (Harland)..... 852
Breitenbach, Dr. W..... 365
Brennan, G. A..... 268
Brewster, Sir David, Sketch of..... 546
Brooks, Professor W. K..... 323
Büttner, Rev. C. G..... 99

Cacao, Cultivation of..... 141
Calculating-Machines..... 441
Campbell, Cl. T., M. D..... 524
Cancer, English Experiences with..... 688
Cancer, Increase of..... 572
Canker-Worm, The..... 569
Cannibalism as a Custom..... 205
Capacities, A Blind Man's..... 861
Cave-Men, The Esquimaux and the..... 287
Cell, Structure and Division of the Organic..... 810
Chavannes, Albert..... 269
Chemistry, The, of Cookery..... 91, 217, 368, 517, 671, 819
Chemists, Official, The Association of..... 286
Children, Omaha..... 574
Children's Parties, Evils of..... 572
Chilian Volcanoes, Active and Extinct..... 88
Chimpanzee, Psychology of the..... 853
Chinese Ancestral Worship, Origin of..... 861
Cholera..... 503, 621, 750
Chronology of the Fossil Flora..... 574
Cities, Wild Birds in..... 718
Civilization, Rapid Perils of..... 224
Clarke, Frank Wigglesworth..... 577
Classics, Question, the, German Testimony on..... 20
Collection, the Lapham, The Loss of..... 568
Collet, Oscar W..... 376
Consciousness, The Nervous System and..... 731
Continent, A Former Southern..... 428
Contrast, Is the, valid?..... 126
Cookery, The Chemistry of..... 91, 217, 368, 517, 671, 819
Correspondence..... 267, 553, 840
Cotton Production, The, of Alabama..... 422
Craighead, J. B..... 39
Crothers, T. D., M. D..... 187
Culture, The Relation of Science to..... 557
Cumberland Sound and its Eskimos..... 768
Customs, Old, of Lawlessness..... 105

D'Alviella, Count Goblet de..... 779
Damaraland, Domestic Arts in..... 99
Davies, Nathaniel E., L. R. C. P..... 213

PAGE

Death-Rates, Sick-Rates and 524
De Saporta, M. Antoine..... 529
Development, Industrial, Science and..... 429
Dolphin, Superstitions about the..... 691
Dominica, A Naturalist's Excursion in..... 679
Drift-Copper in Iowa..... 856
Dunn, H. P., F. R. C. S..... 688

Earthquake, The, of September 19th 424
Earthquake, Recent, Extent of the..... 268
Economy of Light..... 423
Edible Birds'-Nests, Gathering..... 430
Edis, Robert W., F. S. A..... 379, 826
Editor's Table..... 124, 269, 407, 554, 701, 841
Education, A Project in Industrial 632
Electrical Conference, the, Discussions at..... 286
Electricity, What is?..... 76
English Board-Schools, Over-pressure in..... 862
Esquimaux, The, and the Cave-Men..... 287
Evolution and the Destiny of Man..... 456
Expert Testimony, Medical..... 603
Eye-sight, The, Importance of cultivating 715

Fast Modern Life, Suicide a Product of..... 857
Ferment-Organism, The, in Plant-Growth..... 715
Fernald, F. A..... 20, 336, 796
Field-Experiments in Agriculture..... 498
Fire-Insurance, A Chapter in..... 759
Fish and Fishing in Chinese Waters..... 652
Floods, the Ohio, Causes of..... 840
Flora, Chronology of the Fossil..... 574
Flora, North American, Characteristics of..... 422
Flowers, Queer..... 177, 553
Fog-Particles, Experiments with..... 570
Food and Feeding..... 468
Food for Mice, Oil and Earths as..... 857
Fossil Human Skeletons, Antiquity of 430
Fouillée, Alfred 194
Fowls, Domestic Parasites in..... 714
Fuel, Natural Gas as a Source of..... 142
Fungi, How, live in Winter..... 611

Gases, the Elementary, Liquefaction of 249
Gas, Natural, as a Source of Fuel..... 142
Geographical Society, The Oldest..... 717
Germany, Studying in..... 347
Girls, Physical Training of..... 495
Gladiators of the Sea..... 336
Glashan, J. C..... 169
Glass, Phosphoric, and its Applications..... 427

PAGE

Habit, Curious Change of..... 268
Hall, Lucy M., M. D..... 495
Hall, Professor James, Sketch of..... 120
Halsted, B. D., Sc. D..... 611
Hamilton, Dr. Frank H..... 603
Hammond, William A., M. D..... 1
Harrison and Spencer on Religion..... 407
Harrison, Comte, and Spencer..... 125
Harrison, Frederic..... 299
Harvard, Progress of..... 841
Herbert, Sir Auberon..... 353
Hibernation of Snakes..... 424
Homologies between North America and Europe..... 426
Horse, Przevalsky's Wild..... 571

Iles, George..... 759
Illusory Memories..... 423
Industrial Education, A Project in..... 632
Influences determining Sex..... 323
Insect-eating Men..... 573
Insects, The Parental Foresight of..... 694
Instinct, The Darwinian Theory of..... 586
Interior, the Earth's, The Condition of..... 569
International Medical Investigation..... 572

Jametel, M. Maurice..... 652
Jamin, Jules..... 249
Jewish Success, A Jewish Explanation of..... 275
Johow, Dr. Fr..... 679
Jury System, the, A Glance at..... 289

Kennedy, Professor Horace M..... 347
Krakatau's Present Condition..... 425
Krakatoa, the, Air-Wave, Velocities of..... 423
Kulischer, Herr M..... 105

Land-Animal, The Oldest..... 714
Languages, American, Major Powell on..... 425
Language-Studies, The Conflict of..... 703
Lapham Collection, the, The Loss of..... 568
Last Words about Agnosticism..... 310
Laughlin, J. Laurence, Ph. D..... 721
Lawlessness, Old Customs of..... 105
Le Sueur, W. D..... 456
Life, The Painless Extinction of..... 641
Lighthouse-Lights, Testing..... 719
Light, Economy of..... 423
Lighting, Electric, in America..... 714
Liquefaction of the Elementary Gases..... 249
Liquor Legislation..... 787

PAGE
Literary Notices 128, 277, 413, 559, 706, 845
Literary Work, Hard 571
Lock, C. G. Warnford 482
Lucas, M. Edouard 441

Man, Evolution and the Destiny of 456
Marine Life, Protective Mimicry in 365
Mason, E. C 840
Materialism, A Healthy 409
Materialism, The Bad Logic of 701
McMillan, G. C 554
Mears, L. D 268
Meats, Strange, Tastes for 717
Medical Investigation, International 572
Memories, Illusory 423
Men, Insect-eating 573
Meridian, Prime, The International, Conference 421
Metaphysics, Agnostic 299
Meteorological Society, The New England 854
Mica, Industrial Uses of 716
"Mind as a Social Factor" 554
Mind, the, The Relations between, and the Nervous System 1
Morris, Charles 810
Mountain Observatories 388
Muata Yanvo, Family Relations of the 860
Museums, Limited, Advantages of 376

National Defense, Heavy Ordinance for 854
Negro, The Future of the, in the South 39
Nervous System, The, and Consciousness 731
North America, Homologies between, and Europe 426
North, Franklin H 632
Notes 143, 287, 431, 575, 719, 863
Numbers, Forbidden 716

Observatories, Mountain 388
Observing Faculties, the, School-Culture of 169
Ochsenius, Dr. Karl 88
Oddities of Animal Character 261
Oil-Supply, The, of the World 108, 252
Omaha Children 574
Opium-Habit, Treatment for the 860
Overhead Wires, Danger from 427
Over-pressure, Against, in Schools 426

Painless Extinction of Life, The 641
Parasites in Domestic Fowls 714
Parental Functions, State Usurpation of 352
Patagonian Geology 428
Perils of Rapid Civilization 224

PAGE

Pests, New, in Exchange for Old 719
Pettenkofer, Dr. Max von 503, 621, 750
Phenomenon, A Novel 554
Philanthropy, Scientific 269
Philosophy, Origin of the Synthetic 30
Phosphoric Glass and its Applications 427
Physical Training of Girls 495
Placzek, Dr. B 541
Plant-Growth, The Ferment Organism in 715
Plants, Flowering, as Ozone-Generators 568
Political Economy, The Character and Discipline of 721
Politics and Science 412
Politics, Science in 577
Pooley, J. H., M. D 357
Popular Miscellany 138, 282, 421, 568, 714, 853
Population, Health and Density of 859
Powell, J. W 452
Powell, Major, on American Languages 425
Powell, S. W 67
Power, Political, The Abuse of 273
Prime Meridian, The International, Conference 421
Pringle, Allen 803
Protective Mimicry in Marine Life 365
Pulse-Waves, Velocity of 424
Pyburn, George 553

Quatrefages, M. de, Sketch of 697
Queer Flowers 177, 553

Railway Employés, The Sight and Hearing of 433
Rainfall as affected by Wind 858
Recesses, School, Value of 570
Religion and the Doctrine of Evolution 239
Religion, Harrison and Spencer on 407
Richardson, Benjamin Ward, M. D., F. R. S 641
Romanes, G. J., F. R. S 586
Roscoe, Sir Henry, Sketch of 402

Sandstone, Atmospheric Action on 427
School-Culture of the Observing Faculties 169
School Management, Science in 269
School Recesses, Value of 570
Schools, Against Over-pressure in 426
Schools, My, and Schoolmasters 330
Science and Industrial Development 429
Science in Politics 577
Science in School Management 269
Science, Politics and 412
Science, The Relation of, to Culture 557
Scientific Education, The Larger Import of 452

PAGE
Scientific Philanthropy 269
Scorpion-Lore verified 855
Scylla and Charybdis of Administration, The 842
Sea, the, Gladiators of 336
Sea-Water, Properties and Constitution of 529
Sex, Influences determining 323
Short-sightedness, The Question of, in French Schools 142
Sick-Rates and Death-Rates 524
Sight, The, and Hearing of Railway Employés 433
Skeletons, Fossil Human, Antiquity of 430
Slater, James F 840
Snail-Culture 573
Snakes, Hibernation of 424
South, The Future of the Negro in the 39
Sowing Fertilizers 856
Spencer, Harrison, Comte and 125
Spencer, Herbert 30, 310
Spider-Threads for Economical Uses 718
Starvation, its Moral and Physical Effects 213
Stephens, C. H 289
St. Johnston, A 205
Studying in Germany 347
Success, Jewish, A Jewish Explanation of 275
Suffrage, The Problem of Universal 194
Sulphur and its Extraction 482
Sweat, Bloody 357

Tastes for Strange Meats 717
Temple, F., D. D 289
Thermometers, Local Variations in 855
Thomson, William, M. D 433
Time-keeping, The Reformation in 145
Time, The Accurate Measurement of 659
Tobacco, Effects of, on Youth 427
Torrent, Drowning the, in Vegetation 67
Town-Houses, Internal Arrangement of 826
Town-Houses, The Architecture of 379
Trance, Alcoholic 187
Trowbridge, Professor John 76
Trowbridge, Professor John, Sketch of 836
Tylor, E. B., F. R. S 152
Tylor, Edward B., Biographical Sketch of 264
Tyndall, Professor John 330

Universal Suffrage, The Problem of 194
Unknowable, The Religious Value of the 779
Usurpation, State, of Parental Functions 352

Vegetation, Drowning the Torrent in 67
Volcanoes, Chilian, Active and Extinct 88

PAGE
Wampum 425
Weather? the, Do Animals foretell 840
Why Birds sing 541
Williams, Gorham D. 787
Williams, W. Mattieu 91, 217, 368, 517, 671, 819
Willson, Theo. B. 659
Wind, The, as a Land-Carver 423
Wine Statistics of the World 429
Wires, Overhead, Danger from 427
Withington, C. F., M. D. 224
Woolen Underclothing, Advantages of 428

Young, Professor C. A 46

Zuñi Civilization, Development of 860
Zoölogist, Aristotle as a 796

END OF VOL. XXVI.